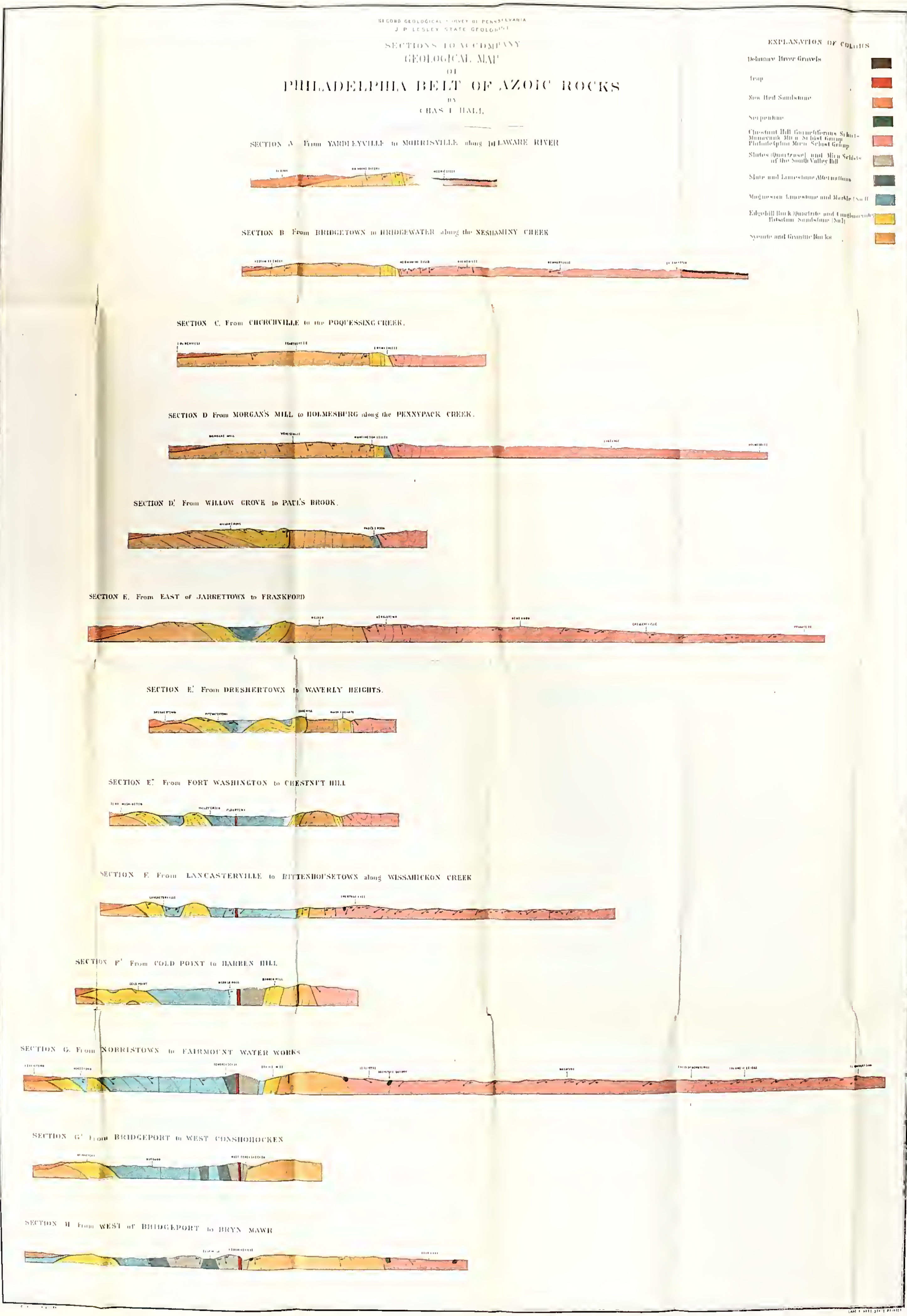
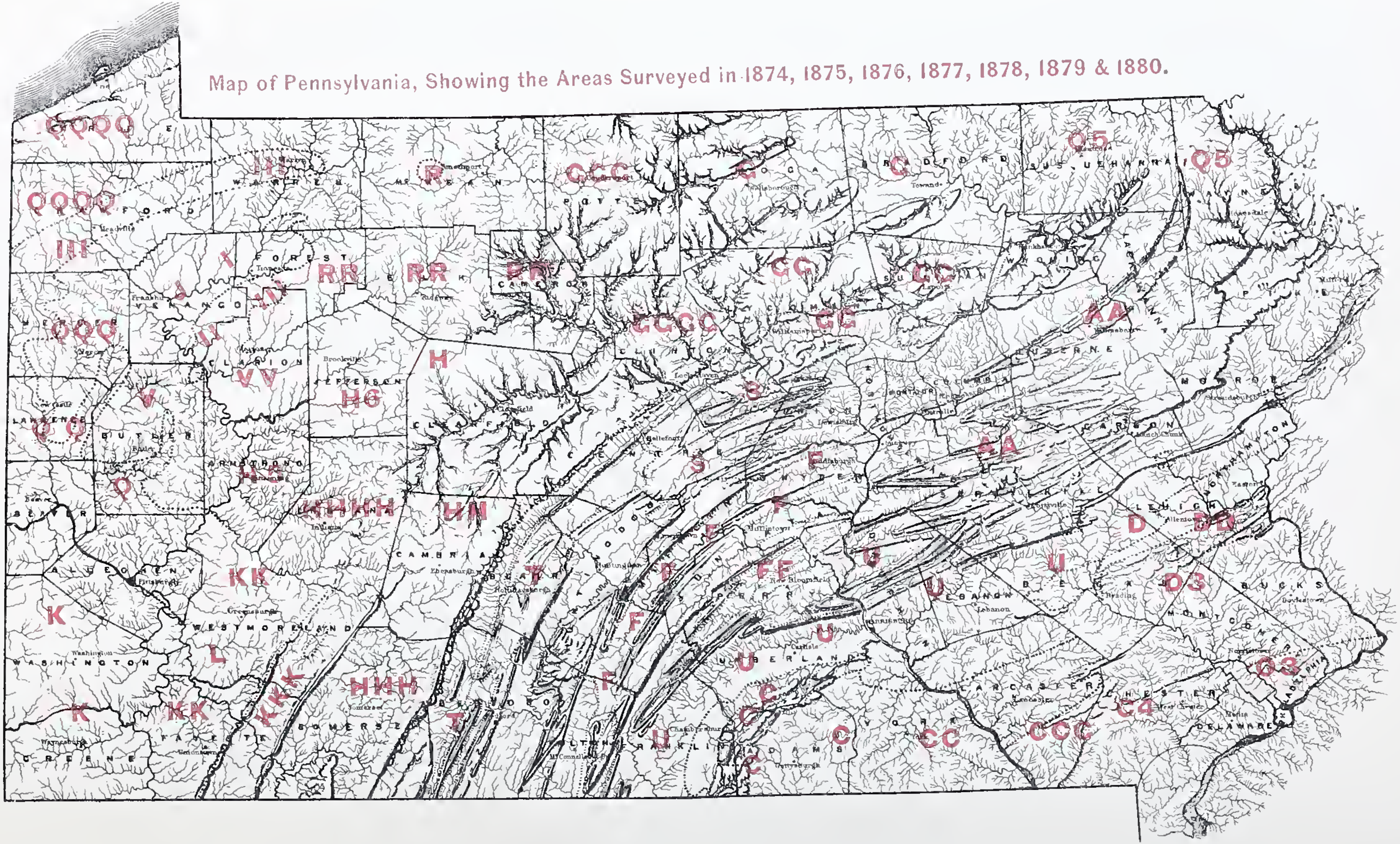

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA
J. P. LESLEY STATE GEOLOGIST
SECTIONS TO ACCOMPANY
GEOLOGICAL MAP
OF
PHILADELPHIA BELT OF AZOIC ROCKS
BY
CHAS. E. HALL.
EXPLANATION OF COLORS
Delaware River Gravels
Trap
New Red Sandstone
Serpentine
Chestnut Hill Garnetiferous Schist-
Manayunk Mica Schist Group
Philadelphia Mica Schist Group
Slates (Quartzose) and Mica Schists
of the South Valley Hill
Slate and Limestone Alternations
Magnesian Limestone and Marble (No II)
Edgehill Rock (Quartzite and Conglomerate)
Potsdam Sandstone (No I)
Syenite and Granitic Rocks
SECTION A. From YARDLEYVILLE to MORRISVILLE along DELAWARE RIVER
SECTION B. From BRIDGETOWN to BRIDGEWATER along the NESHAMINY CREEK
SECTION C. From CHURCHVILLE to the POQUESSING CREEK.
SECTION D. From MORGAN'S MILL to HOLMESBURG along the PENNYPACK CREEK.
SECTION D'. From WILLOW GROVE to PAUL'S BROOK.
SECTION E. From EAST of JARRETTOWN to FRANKFORD
SECTION E'. From DRESHERTOWN to WAVERLY HEIGHTS.
SECTION E". From FORT WASHINGTON to CHESTNUT HILL
SECTION F. From LANCASTERVILLE to RITTENHOUSETOWN along WISSAHICKON CREEK
SECTION F'. From COLD POINT to BARREN HILL.
SECTION G. From NORRISTOWN to FAIRMOUNT WATER WORKS
SECTION G'. From BRIDGEPORT to WEST CONSHOHOCKEN
SECTION H. From WEST of BRIDGEPORT to BRYN MAWR



Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878, 1879 & 1880.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS

C^6.

THE

GEOLOGY

OF

PHILADELPHIA COUNTY

AND OF

THE SOUTHERN PARTS

OF

MONTGOMERY AND BUCKS.

By CHARLES E. HALL.

WITH ANALYSES OF ROCKS.
BY DR. F. A. GENTH,
AND F. A. GENTH, JR.

ILLUSTRATED BY
A GEOLOGICALLY COLORED MAP, IN THREE SHEETS;
ONE SHEET OF COLORED CROSS SECTIONS
24 PAGE CUTS, AND TWO INDEXES.

HARRISBURG:
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LETTER OF TRANSMITTAL.

To His Excellency GOV. HENRY M. HOYT, *Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania :*

SIR : I have the honor to transmit for your consideration a carefully elaborated report on the geology of the rocks of the Lower Delaware and Schuylkill rivers, by Mr. Charles E. Hall ; inviting your attention to the following particulars :

1. The text of the report has been condensed and systematized as much as possible.

Readers unacquainted with the subject will get from it no idea of the amonnt of time and labor spent upon the investigation. Mr. Hall has not only studied every individnal exposure at least once, and the more important ones repeatedly, but has obtained from them several thousand hand-specimens, now in the Museum Collection of the Survey ;* so numbered and labeled as to be at any future time analyzed, studied by the microscope, compared in suites with one another, and each one compared with the mother rock of its locality.

Part of this work has been already accomplished.

Dr. Genth's analyses, both chemical and microscopic, of the more important varieties, presenting types of rocks characteristic of the belts which cross the district, make np the second part of this report ; but the special lithological investigations of these and other rocks of the State, by Dr. Genth are reserved for publication in his own Mineralogical Report.

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* The catalogue of these specimens has been printed in Report OO, 1880 ; and this will explain the use of the lettering OO throughout the latter half of the book.

An Index to specimens thus described and analyzed will be found at the end of the Volume.

An Index of their localities will be found included in the general Index to the names of persons and places mentioned in the report.

No geological Index is given with this volume, because the different formations are defined, each under the head of its name, in the general description, and also in the description of each township.

2. *Illustrations.*—A few *cross-sections* (Figs. 10 to 24) are inserted in the text (pp. 32 to 45) to explain the exceptionally difficult structure along the lines of contact of the Limestone, Sandstone, Gneiss, and Slate formations, stretching from Trenton on the Delaware river at the east end of the district, to Chestnut Hill, Spring Mill and Conshohocken on the Schuylkill at the west.

A sheet of *cross-sections*, colored geologically, accompanies the report. These sections are arranged in a geographical series over one another; so that the reader, imagining himself in the air west of the Sckuylkill, and looking east towards Trenton, sees the geological changes which take place from section to section in that direction.

Such a representation is better than any verbal description. Such a description, however, has been attempted by Mr. Hall in the Introduction to his local or township report; but it will require careful reading, with constant reference to this sheet of sections and to the map.

A large *colored geological Map* of the district, in three sheets, (which can be put together as a wall map,) accompanies the report. It has been made with extraordinary care, on a large scale (3520′ : 1″), from the best maps extant; and, where defects were discovered by the geologist, special surveys were made with the transit instrument. The Delaware river sheet of the Coast Survey furnished the southeastern basis. The very accurate Philadelphia City survey maps, and the contoured map of the Park Commissioners, were amply sufficient for the southern quarter of the district. The Reading Railroad line along the Schuylkill originally fixed the geography of that valley. The Pennsylvania Railroad line, eastward, was used as a base of reference for all outcrops in the southern townships of Bucks county ; and new surveys were made along the Bound Brook railroad line where important readjustments of its relation to cross roads, and rock exposures were called for.

This Map is therefore not merely an illustration of the Delaware-Schuylkill geology, but a valuable original contribution to geographical knowledge in southeastern Pennsylvania ; and reflects credit on Mr. O. B. Harden who executed it.

In consulting the Map, it must not be supposed that the geology of the district is fully understood. Geologists will have much to discover in years to come. A deep obscurity still shrouds parts of its underground structure and constitution, especially west of the Schuylkill. But so far as surface indications can be obtained they have been carefully collected, collated and illustrated in this report.

The surface of the country is under high cultivation. The water courses are shallow. Extensive areas are masked by recent gravel and clay deposits. Rock exposures, although numerous, are small and isolated. Plications, faults and even overturns are the rule rather than the exception ; and metamorphism is universal. Mineral beds are rare. Fossils are absolutely wanting. Characteristic lithological features are evident enough on a large scale ; but when looked for on a small scale they fail the geologist at every step of his progress, along any belt of outcrop, and fade into each other, or repeat themselves and alternate so rapidly and monotonously, in the visible groups of strata exposed, that special classification in vertical order becomes almost impossible.

The Map must therefore be of future rather than of present value, as it will enable geologists to locate with precision all new discoveries ; in particular, enabling them to correlate sections obtained by artesian well-borings ; and on such borings the future systematic geology of the district must chiefly depend.

3. *The Series of Formations.*—In coloring portions of the Map all the difficulties which have so long stood in the

way of a correct classification of our Azoic rocks were displayed.

In coloring any Palæozoic district of the State a geologist is chiefly embarrassed to select judiciously a series of colors for the outcrops of a continuous series of superposed formations, the relative ages of which are well known ; and even when the underlying Azoic formations come into the limits of such district map, all that is required is to select some additional color, not included in the Palæozoic or Mesozoic series.

But in the case of the Map before us very different difficulties arise ; for, here, we have a country of mica schists, garnet schists, granitic, syenitic, hornblendic and micaceous gneisses,—with included serpentine, steatite, talc schists chrome iron beds, and disseminated gold,—all of them rocks which it is still impossible to assign with the least confidence to any age.

Mr. Hall has distinguished *three subdivisions* of the rocks exposed along the Schuylkill river from its mouth up to Conshohocken : 1. the Philadelphia group ; 2. the Manayunk group, and the 3d. the Chestnut Hill group ; and supposes them to underlie each other in that order ; the Philadelphia group being the lowest ; the garnetiferous schists of Chestnut Hill, with its serpentines, the highest ; and the latter group synclinal in its structure.

These groups occupy the surface along belts, across which the Schuylkill river cuts, and over which the Delaware river gravels, sands and clays spread broadly.

Each of the three groups is several miles wide on the Schuylkill, and narrows, taperingly, eastward, to a point at Trenton. But, while the *Manayunk* and *Chestnut-hill* groups seem to actually taper eastward, the *Philadelphia* group presents only the appearance of tapering, or narrowing, eastward ; that appearance being due merely to the fact that the belt becomes more and more covered and concealed by superficial river deposits, underneath which it no doubt spreads.

None of these Schuylkill rocks are seen in New Jersey ; because their ancient and eroded surface sinks beneath the

Mesozoic red shales and sands, and the Cretaceous clays. But the Schuylkill rocks rise again to the surface on Staten and Manhatten Islands; and spread into southern New York, and through Connecticut.

Mr. Hall's survey of Delaware county has only advanced far enough to show that the Schuylkill rocks extend to Chester creek, and are there cut off (geographically) by a country of older Laurentian gneiss, between Chester creek and the Brandywine. What this means is still a subject of investigation; but two facts are known:

a. The Serpentine belt of Bryn Mawr, instead of running on its normal southwest course through Delaware and Chester county towards Maryland, swings round southward in a curve towards Chester on the Delaware; not in an unbroken line, but in a series of projections, like the teeth on a circular saw, some of which reach Chester creek.

b. The N. East strike of the rocks of the three groups on and east of the Schuylkill is suddenly (to appearance), in Delaware county, replaced by a normal north and south strike. This however may prove to be a deception; for there are suggestions, at some of the exposures, of a normal, nearly horizontal, north-west dipping, almost obliterated *bedding;* which if accepted, would compel us to regard the universally visible N. and S. strike lines as those of *cleavage.*

This is enough said to display to practised geologists the extraordinary difficulties encountered in studying the geology of this part of the State. But the attention of readers of Mr. Hall's report should be earnestly invited to another and still more striking series of observations:—

Besides the *three groups* mentioned above, and the belt of *Laurentian gneiss* which limits them on the north and west, there is a *fourth group* of mica (or hydro-mica) schists, with gneissic beds, running along the north side of the *Laurentian gneiss* belt, from the Schuylkill westward, through Chester and Lancaster county.—This mica-schist group forms the South Valley Hill, overlooking the Downingtown-Norristown limestone valley; the North Valley Hill, opposite, being made by Potsdam sandstone, No. 1.—

All the dips of the sandstone are *southward* under the limestone; which is therefore No. II.—All the dips of the limestone in the valley are *southward* under the mica-schists; which therefore (in the absence of any fault) ought to be Utica, or Hudson River slate, No. III, completely changed in its lithological aspect and deprived of its fossil forms, by metamorphism.

This is the view adopted by Mr. Hall, and supported by his explanation of the structure of the east end of the South Valley Hill opposite Conshohocken on the Schuylkill.—If this view be adopted, then a large part of southern Chester and Lancaster counties must be considered *Hudson River* territory; and then, also, the presence of *Hudson River plant forms* in the roofing slate quarries of the lower Susquehanna river valley, at the Maryland line, (as shown in Prof. Frazer's Report C^2.) can be easily understood.—But, on the other hand, a radical and in some respects a satisfactory readjustment of our structural explanations in the Columbia and York neighborhoods becomes inevitable.

No more need now be said of this, pending the progress of the survey in Delaware county; except to indicate its bearing upon the question of the age of the *three Schuylkill groups.*

Mr. Hall shows that the *Chestnut Hill group* (apparently the uppermost) abuts northward against the *Laurentian gneiss* in part of its course; against the *Pottsville sandstone*, in another part of its course; against the limestone, in other places; and against the mica-schists in still other places. Nowhere along the line can the true structural or chronological relationship be discovered; neither can the certain existence of a line of faulting be proved, nor (if proved) its relative quantity be even approximately estimated.

All that Mr. Hall feels justified in asserting is that the *three groups* of the Schuylkill, constituting a mass of sediments of immense thickness (certainly 10,000, and possibly 20,000 feet thick) cannot be placed between the Laurentian gneiss and the Potsdam; nor between the Potsdam and the Limestone; nor between the Limestone and the Mica-schists; consequently must be either a *repetition of the Mica-Schists* on the South side of the *Laurentian gneiss* belt; or, a series of formations *overlying* (in age) *the Mica-Schists.*—But if the Mica-schists be No. III (*Hudson River*), then the Philadelphia, Manayunk, and Chestnut hill rocks, must be Medina, Clinton, Helderburg, Hamilton, Chemung, &c. &c.

Prof. John F. Frazer, of the First Geological Survey of Pennsylvania in 1836, came to this conclusion; but with a difference, viz: that, at that time the Canadian geology had not been worked out, and the *Laurentian gneiss* formations had no existence for geologists. Consequently Prof. Frazer regarded the Laurentian gneiss of Delaware and Chester counties as *metamorphosed Oneida and Medina* No. IV; a view which is now untenable, as shown by Mr. Hall's report.—But with this most important exception, Mr. Hall's conclusions carry us back to the old hypothetical ground of Frazer, James Hall, H. D. Rodgers and others, who, in opposition to Dr. Emmons, regarded the rocks of Eastern New York, and Western New England as metamorphosed Lower and Upper Silurian. Prof. Dana's more recent explorations of the Vermont rocks, and of the Highland country on the east side of the Hudson river, have given a higher probability to this view; and since Mr. Hall has personally compared the Philadelphia rocks with those studied by Prof. Dana, and can see no essential difference between them, we can accept the Palæozoic age of the Philadelphia rocks with a moderately reserved confidence. To regard any of them as of Devonian age certainly requires a strenuous effort of the imagination; but, for my own part, inasmuch as I became impressed thirty years ago with the feeling that eastern Connecticut and middle Massachusetts were occupied by metamorphosed No. VIII (Hamilton, Portage, Chemung), and that the southern White Mountains, around Mad river, were metamorphosed No. IX (Catskill), I am prepared to accept evidence of the Devonian age of the Philadelphia rocks, without prejudice, whenever it shall be properly presented.

Two difficulties stand in our way:—First, the numberless faults visible along the Schuylkill river between Fairmount and Conshohocken. If we knew the quantity of downthrow represented by each of these faults, we could measure the total thickness of the *three groups.* In appearance these faults are small ; but some of them may be large.

If it were not for these faults, we could assert that from the Kaoline outcrops at Gray's ferry up to the soapstone quarries above Manayunk the total pile of micaceous and hornblendic schists and gneisses measured about 25,000 feet ; representing in ancient times a mountain range as high as the Alps ; now eroded nearly to a level nowhere more than 400 feet above sea level.

But in the presence of innumerable faulty and many minute plications, such a measurement becomes extravagant ; and it is possible that enough repetitions of the same beds occur to diminish the total thickness (estimated from dip) to 10,000 feet, or even less.

The other difficulty is of a different kind. The region of Philadelphia rocks is separated from the Palæozoic region of middle Pennsylvania by an interval of 40 or 50 miles ; except where the Potsdam and Magnesian limestone (I and II) come up through the Mesozoic at Newhope on the Delaware river. Consequently we cannot tell what changes to expect in the Devonian (nor in fact in the Silurian) deposits over this interval. But inasmuch as there is an *increase* in thickness *southward* throughout the whole Palæozoic back-country area, we might conclude that this increase would be represented, as far south as Philadelphia, by a vastly greater thickness of Devonian deposits even than in Middle Pennsylvania. At the same time, such a supposition would be hazardous in the extreme.

At Pottsville the *Laurentian gneiss* must be at least 40,000 feet beneath the surface. At Conshohocken it comes to the surface. East of Reading its eroded surfaces stand 1000 feet above sea level. In Delaware and Chester counties it must have formed formerly high mountains. The conglomerates of Potsdam age described in this report, by Mr. Hall, show that there was dry land in early Palæozoic times. The cutting off of the Schuylkill rocks at Chester creek looks like local deposition. All speculation is therefore fruitless and we are left in almost total ignorance of the real state of things.*

4. One of the most interesting features of the geology of this district is its superficial covering of gravels, sands and clays brought down by the Delaware and Schuylkill rivers in earlier stages of their history. But a description of these deposits is reserved for the report on Delaware county. Mr. Henry Carvill Lewis has been engaged for two years in their study, and is now tracing the *glacial moraine* deposits across Pennsylvania.

He has traced the great moraine of the ice sheet from where it crosses the Delaware river, near Belvedere, below the Water Gap, as a high ridge of *till*, in an approximately straight line, north of west, to Beach Haven on the North Branch Susquehanna river; and thence to near Ralston on Lycoming creek; passing diagonally over mountains and valleys without swerving from its course.

Starting from Belvedere it curves up to the Fox Gap; passes through Saylorsburg and Broadheadsville; winds round Pocono Knob; ascends the great escarpement to the plateau; descends and crosses the gorge of the Lehigh river at Hickory run, five miles below White Haven; thence runs in a nearly straight line to Beach Haven on the Susque-

* Dr. T. Sterry Hunt's Special Report (E) on the Trap Dykes and Azoic Rocks of Southeastern Pennsylvania, Part I, Historical Introduction, was published by the Board in 1878. The second part of the report has not yet been transmitted by the author.

Dr. Hunt learnedly exposes the diversity of views respecting the Azoic rocks of the Atlantic seaboard held by geologists; and, by inference, the extraordinary difficulties encountered in the study of their structure, age, and mutual relationship.

His own opinion is pronounced in favor of the Philadelphia gneisses being of Montalban (White mountain) age, (E, page 200, § 386;) his series of American formations being (in descending order) Cambro-Silurian, Taconian, Montalban, Huronian, Norian, Laurentian, (E, page 210, § 405.)

But general considerations must give way to long continued systematic research in special districts; and the Taconic theory, as a whole, has become so undermined by recent systematic fieldwork in Vermont and Eastern New York, as to be no longer tenable; which greatly relieves the student of the Philadelphia belt from prejudices in favor of the pre-Potsdam age of its Azoic rocks.

hanna river; and thence trends toward Bodinesville and Ralston.

At the Delaware Water Gap are terraces, kames, medial moraines and glacial striæ in abundance. But the great ice sheet passed diagonally over the top of the Blue (Kittatinny) mountain without heeding the gap in the mountain.

On the very crest of the mountain Mr. Lewis found a block of Helderburg limestone, more than six feet long, which had been torn from the ridge in the valley below, five miles distant.

Other bowlders of the same limestone, some of them more than thirty feet (30′) long have been carried over the top of the mountain and now lie on the upturned edges of the Hudson River State formation south of it.

Striæ abound on the mountain, but none are to be seen showing the ice to have gone through the gap, although they show that it crossed the gap diagonally. There is no evidence that the ice went through the Wind Gap, or the Lehigh Water Gap. The hill of *drift* at Portland is a *medial kame.*

Mr. Lewis also announces the important discovery of a distinction between scratches made by the moving ice itself, and other cross scratches made by long subsequent sliding of the glacial *till* down slopes over rock surfaces. To these he has given the name of *creep striæ*, because they are due to the creeping of the moraine matter down hill in post-glacial times.

Blocks full of Oriskany fossils, are found lying embedded in surface clays in West Philadelphia. These blocks must have come down the Schuylkill valley 60 miles, from behind the Blue mountain, the nearest outcrop of the rock. Some of them may have been brought down the Delaware from the Water-gap. Whether solid ice ever reached Philadelphia is more than doubtful. Floating fragments of the back-country glaciers undoubtedly reached the Philadelphia neighborhood. Prof. W. B. Rogers describes similar facts at Washington; and Richmond in Virginia. The blocks in West Philadelphia lie more than 100 feet above tide, as Mr. Hall, who first studied them, showed.

But more ancient gravels are found 400 feet above present tide level at Bryn Mawr and elsewhere on the northern verge of the wide valley of the Delaware, and these are shown upon Mr. Hall's geological map. Others have been found at corresponding levels in New Jersey and will be described by Mr. Lewis, who assigns them, problematically, a tertiary age. At the same elevation of 400′ gravels are found at Easton and at Bethlehem on the Lehigh river, in Northampton county, 50 miles back of Philadelphia. Gravels of a high elevation are noticed by Prof. P. Frazer in his Lancaster county report, and these are connected with the water system of the Susquehanna river.

It is a question whether the ocean level stood at that time, 400′+ higher than at present.

It is however quite certain that the Delaware river once flowed in a channel several hundred feet above its present bed and has cut down since then to its present level. Its deposits of various age are visible in terraces and patches at various elevations, as Mr. Lewis' report will show. This is in conformity with what we know of most of the rivers of the world.

So the river Seine once had a much higher, very wide, and almost straight water way from Paris to Havre, 141 miles. Now its sunken channel, winding in horse shoe beds, measures 152 miles from Paris to Rouen, and 76 miles more from Rouen to Havre. The plains of Versailles and St. Denis are of river sand; and extinct animals are found in the sand pits. Between Charonne and the Barière d'Italie the width of the sand shore is 3¾ miles; and excavations in the sand of the Marne are 200 feet above tide.

In the valley of the Somme, made famous by the discoveries of Boucher de Perthes at Abbeville, on the road from Paris to Calais, while peat bogs occupy the present water plain, terraces of gravel occur at various elevations towards the tops of the side hills, the highest being the oldest, and show the successive stages at which the river has deepened its channel. In these gravels remains of prehistoric man have been found.

Similar gravels line the sides of the Delaware river valley, and human implements of a remote antiquity have been found in them at Trenton.

With these indications of the past and future work of the Survey, in this district, I transmit the Report of Mr. Hall, and am,

Sir, very respectfully,

Your obedient servant,

J. P. LESLEY.

1008 CLINTON ST., PHILADELPHIA, *July 6, 1881.*

Prof. J. P. LESLEY, *State Geologist:*

SIR: I herewith submit to your consideration my report of progress in surveying the geology of the Philadelphia district between the southern margin of the Mesozoic Sandstone and the Delaware river from Trenton, to the Chester and Delaware county lines on the west.

The area includes the southern edge of Bucks and Montgomery counties and the whole of Philadelphia county.

It will be seen from the accompanying maps that the geology of this region is complicated, and that some of its details are not yet completely explained. The general areas are the same as those recognized by Prof. Rogers, and in particular instances the detail of structure is more minutely delineated by him, than I have felt justified in indicating upon my map.

It has been my object to locate accurately the areas of the different belts of the metamorphosed rocks; but in some few places it has not been possible to ascertain the underlying rock.

Through many sections of the district there are few exposures and the character of the underlying formation has to be determined by the soil.

When there is doubt as to the exact limit of a belt, the color denoting the rock is *lined* upon the map.

The relative age of the different belts I have pretty well demonstrated.

The Itacolumite, or Edge Hill Rock, I consider proven, beyond dispute, to be the equivalent of the Potsdam Sandstone.

The rocks upon which this Potsdam rests are what are at present called Laurentian. The so called *Huronian* of Philadelphia I consider more recent than the Potsdam sandstone (No. 1,) and overlying Cambrian limestones (No. II) of the Chester valley.

I have been forced to these conclusions from facts observed within this district.

I may here state that the schists south of the Highlands, along the Hudson river, in New York, bear the same relation to the Fishkill Cambrian limestone of (No. II) that the Philadelphia schists bear to our Cambrian measures.

The Mesozoic sandstone I have not studied in detail.

The mica schists and gneisses I have divided into three belts provisionally. A better subdivision may be found for them after further survey of adjoining counties.

Geological specimens have been collected throughout the entire district and catalogued in Report O^2, and under letters corresponding to those indicating section lines on the geological map.

I have the honor to be,

Your obedient servant,

CHARLES E. HALL.

907 WALNUT ST., PHILADELPHIA, *May 3d, 1881.*

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REPORT OF THE GEOLOGY

OF

PHILADELPHIA,

AND THE SOUTHERN PARTS OF

MONTGOMERY AND BUCKS COUNTIES.

By Charles E. Hall.

Chapter I.

Introduction.

A short summary of the geology of my district as it was understood by Prof. H. D. Rogers, at the close of the First Survey (1836–1841,) and described in his Final Report of 1858, will best explain in what respects my conclusions agree with, and in what respects they differ from his.

Prof. Rogers divides the gneissic and metamorphic rocks of Pennsylvania into three districts. This division is geographical. The zone of country under consideration comprises a portion of his First or Southern district. This Southern zone he sub-divides geologically into three belts. The line of the Schuylkill river was taken as a basis, the exposures along its course affording the best data for a subdivision.

His First belt is cut through from the southern-most exposures on the Schuylkill river to the upper end of Manayunk.

His Second belt is cut through from the upper end of Manayunk, to the upper boundary of the *serpentine range* a short distance above Lafayette station.

His Third belt is cut through from the northern edge of the Second belt to the "northern edge of the whole gneiss formation" and is overlaid by his *primal* rocks at Barren Hill.

Referring to the geological map it will be seen that the only change I make in these sub-divisions is the *insertion* of an intermediate belt at Manayunk.

Rogers' First belt.

The common varieties of the rock of his *First belt* are gray schistose gneiss, composed of quartz, feldspar, and black or brown mica and occasionally garnets, occasional beds of black hornblendic slate and fine-grained sandy gneiss.

Intermediate belt.

The belt now inserted between the First and Second belts of Rogers' contains alternations of the above named varieties of gneiss and a predominance of sandy gneiss, composed of quartz and a small amount of feldspar, and mica in minute flakes. Mica schists and hornblendic slate alternate with finer-grained gneisses; the mica usually light colored.

Rogers' Second belt.

The Second belt of Prof. Rogers (that portion of it which is not included in my inserted belt) is characterized by the serpentines; soapstone; silvery, micaceous, garnetiferous schists; light-colored, thin-bedded sandy gneiss, with disseminated light-colored mica in minute flakes.

A peculiarity spoken of by Prof. Rogers is the fracture; "the rock breaking into long narrow chunks, comparatively smooth on their sides, but excessively ragged on their ends; a style of fracture strongly resembling that of half-rotted, fibrous wood."

Although the steatites and serpentines seem to belong exclusively to this belt and horizon, I find three exceptional localities of magnesian rock lying outside of it.

1. One locality is at Flushing, north of Mill creek, a short distance west of the Neshaminy creek, in Bensalem township, Bucks county. (See analysis 4949.)

It occurs in the mica schists and gneiss of the First belt, (a continuation of the rocks which cross the Schuylkill river in the vicinity of Philadelphia.) Its occurrance seems to be local, no other outcrop having been found in the vicinity.

2. Another exposure of steatite slate is found on the east side of the Wissahickon creek, a short distance below the confluence of Creshiem creek, Philadelphia county. This location would be at, or close to the northern edge of Prof. Rogers' First belt. According to the present arrangement of the rocks it occurs about the center of the middle belt of micaceous gneisses and schists.

3. A third locality is northwest of Mechanicsville, near the south line of Upper Merion township, on the Gulf Mill road. This deposit is probably an eastern extension of a belt of serpentine and steatite which is found in the adjoining county on the west.

The geological relations of these serpentines have not yet been determined, but in all probability some of the serpentines of Chester and Delaware counties occupy a similar position to those characterizing the *Second belt.*

The geological position of this Upper Merion township locality, is between the slates of the South Valley Hill and the *syenite* belt which flanks the slates on the south. It will be seen that the geological relations of this locality are similar to those along the Schuylkill river above Lafayette station, and elsewhere along the south margin of the *syenite belt*, which is described by Prof. Rogers as the *Third belt.*

When the geology of the adjoining counties is thoroughly understood, these facts, concerning the relation of the *serpentines*, will be looked upon as more important than a mere coincidence.

With the above exceptions the serpentines and steatites of the district are confined to the northern portion of the Chestnut Hill *garnetiferous schist* group (the northern portion of Prof. Rogers' Second belt.)

There are two belts of serpentine; the southern one extending from Chestnut Hill to the Delaware county line, a short distance south of Bryn Mawr; the northern belt extends from a point north of Lafayette station, east of the

Schuylkill river, to a point near the Delaware county line, north of Bryn Mawr.

These belts are not unbroken. On the contrary, it is impossible to trace them continuously. The coloring on the map indicates the rock where its existence is beyond question. The two belts are nearly parallel, and on structural grounds there is reason to believe that these bands represent one horizon ; the repetition being due to a sharp synclinal fold which is recognized along the whole northern edge of the schist formation.

Rogers' Third belt.

The Third Belt described by Prof. Rogers, extends from the northern edge of the schistose group, above Lafayette station, to Spring Mill, where it is overlaid by his *altered Primal* or Potsdam. This group of rocks is easily distinguishable from the soft micaceous rocks flanking it on the south ; although in some places along the belt we find slaty micaceous gneiss layers resembling to some extent, rocks which are found in the gneiss groups south of it. The rocks of this Third belt are composed chiefly of quartz, feldspar, and hornblende. The beds are often massive, but usually have thin bands of black mica or hornblende through them. They are syenite and gneissic granets or granitic gneisses. A peculiar variety of bluish quartz is characteristic of this group.

From a narrow neck along the Wissahickon creek, this belt gradually widens westward, and extends eastward from the Wissahickon creek to the Delaware river unbroken.

This rock is much harder than the schists south of it, and consequently withstanding erosion, forms a more or less prominent ridge throughout its entire course.

Its geological relationships.

So far as the structure of this third belt is concerned, and its relation to his *Lower Primal* rock north of it, the arguments advanced by Prof. Rogers are good.

I differ however with regard to its relation to the mica schists and gneiss flanking it on the south.

Although there is a prevalence of northward dip throughout the schists and gneisses of his First and Second belts (or Philadelphia and Manayunk groups) there is no such prevalent north dip in his *Third belt.*

Along the northern edge of the schist group, (*Second belt*) we find a sharp synclinal folding, or *upward brush.* This can be traced from the exposures along the Neshaminy creek to the Delaware county line.

Prof. Rogers concludes that there are but two *two groups* of rocks, and that the '*upper* micaceous rocks filling the synclinal basin,' are underlaid by the rocks of the Third belt rising on the north arm of the synclinal.

The structure however, can not be explained in this way; although his Third belt *is* without doubt the lowest and underlying rock.

A glance at the geological map will show plainly to the reader that his Third belt extends all the way from the Delaware river, above Morrisville and Trenton, to and beyond the Delaware county line. It gradually expands from the vicinity of the Wissahickon creek to the westward, (as described by Prof. Rogers.) It is however not cut off east of the Wissahickon by the *Primal* rocks, as indicated by Prof. Rogers, but can be traced continuously through Montgomery and Bucks counties to the Delaware river. The *altered Primal sandstone* is however cut off in its course; and the arm which extends to the Delaware river does not connect with the main belt which flanks the Chester-Montgomery county limestone valley.

I find the Primal sandstone (Potsdam) wherever it occurs invariably resting upon the rocks of his *Third belt.*

As an argument in favor of the unconformity of the *Primal* (Potsdam) upon this group, I will state that east of Willow Grove, Moreland township, Montgomery county, the *Primal* is a *coarse* sandstone and conglomerate. It is composed of fragments of the characteristic rocks of the *Third belt*, which are principally blue quartz and syenite. The *Primal* (Potsdam) is generally composed of fine sandstone, though occasional beds of conglomerate are met with elsewhere along the belt. Where the pebbles are large enough for study they are found to be invariably composed of the débris of the *Third belt.*

Another noteworthy fact in this connection is, that not a single flake of mica, quartz or other material within the Potsdam, can be found belonging to the First and Second belts of Prof. Rogers.

Following along the northern edge of the mica schists and gneisses of the First and Second belts (the southern margin of the *Third belt*) we find *the schists resting directly upon and against the rocks of the Third belt* along the Schuylkill river.

East of this point, however, *the Primal* (Potsdam) *is found between the two belts;* still further east, limestones are found; and east of this we have limestones (Auroral) and Primal (Potsdam) between the schists and the rocks of the Third belt.

From the Pennepack creek in Montgomery county to the Delaware river the Primal outcrop runs between the Laurentian of the *Third belt* north of it and the schists of the *Second* belt south of it. The schists maintain the same relative position to the Primal and limestones east of the Wissahickon creek, that they do to the Laurentian along the Schuylkill river and west of it.

It is not possible to assume that the mica schists and gneisses of the *First* and *Second belts* are *older* than the Syenite (*Third*) belt for the following reasons: The rocks of the Third belt are identical with the granitoid and syenitic rocks of the Welsh mountain. north of the Chester county limestone valley, the floor rock of the Primal of the North Valley Hill. These rocks of the Welsh mountain are similar in all respects to the crystalline rocks extending into Pennsylvania from New Jersey in the neighborhood of Easton, and forming portions of the mountains between the Delaware and Schuylkill rivers. In New Jersey they are identified as belonging to the Laurentians. Although these rocks are very variable in composition and character, and their subdivisions still rather obscure, there are no extensive deposits of soft mica schists found in them.

It is evident therefore from these facts alone that the mica schists and gneisses are not older than the Laurentians.

But assuming it proved that they are more recent than the Laurentian the question arises, where do they belong?

The structure alone along the Schuylkill river proves them to be more recent than the *Third belt* (Laurentian.) They rest against and upon the rocks forming this belt south of Spring Mill.

It is clear that the Primal (Potsdam) was deposited directly upon the rocks of the Third belt.

But it is also equally clear that the mica schistsand gneisses are not found between the Primal (Potsdam) and the rocks of the Third belt. Therefore if the mica schists were older than the Potsdam sandstone they must have been deposited up to a geographical line which is sharply defined. This would be too extraordinary an occurrence to be accepted without complete proof.

Even supposing a fault, (which in all probability does exist along their northern edge,)* there would be still some remnants of these rocks to be found in their normal position upon the syenites of the Third belt; and fragments of the rapidly disintegrating schists would have been entombed in the Potsdam sandstone itself, even supposing them to have been swept off of the underlying rocks north of the present limit.

The later age of mica schists.

We encounter the same difficulty in assigning the mica schists and gneisses to any place *above* the *Primal* (Potsdam sandstone, No. 1) until we get above the horizon of Rogers' *Auroral* limestones (No. II.)

The dividing line between the deposits of the Potsdam and the limestones is sharply defined; the change of conditions was rapid and the source of material was changed. And there are no intermediate deposits of mica schists and gneisses which might be equivalent to the First and Second belts.

But towards the close of the deposit of the limestones

*This hypothetical fault will be referred to in this report under the name of the *Chestnut Hill* fault.

the conditions were quite different. Throughout the upper portion we find the limestones alternating with slates. Beds of slaty limestone and slate are met with occasionally in the middle and lower portions; but as we ascend, the limestone gradually becomes subordinate and the slates predominate.

These slates (which have been called the South Valley Hill *hydromica* and *chlorite slates*,) were considered by Prof. Rogers as equivalent to his Primal of the North Valley Hill; which is not possible; for the Potsdam sandstone on the north meets the limestone only a few thousand feet from the south side of the valley, where the South Valley Hill slates occur. There are no transition measures between the limestones and the slates of the South Valley Hill. Now, if we assume that the Potsdam in the North hill and the slates in the South hill belong to the same horizon it would follow that there was a belt a few thousand feet wide, extending, from an abrupt commencement near the Schuylkill, southwestward, beyond the Susquehanna river, along the southern side of which a gradual change or transition took place, and on the north side the change was sudden or spontaneous. Such an argument is unreasonable. *The structure alone is sufficient to prove that these slates of the South Valley Hill are not altered Primal*, but no other than a series of slates *overlying* the limestones of No. II.

Following the slates through Chester and Lancaster counties we find them along the Susquehanna river, where in their midst the roofing slates occur. In the Peach Bottom slate quarries we find a fossil (*Buthotrephis flexuosa*) beyond dispute of *Hudson River age.*

Aside from this palaeontological evidence there is sufficient proof of their *Hudson River age* alone from the structural relations. The lower portion of this South Valley Hill belt shows a gradual transition from limestone to slate deposit. Throughout the lower portion of the group there is nothing resembling the gneisses and mica schists of the lower Schuylkill (First and Second Belts of Rogers.)

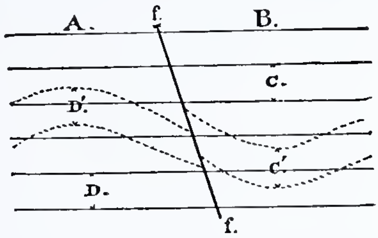
In Chester county in a number of places along the southern or upper edge of the South Valley Hill belt we have observed that there is a marked resemblance in the rocks to those of the Chestnut Hill and Manayunk groups. It is therefore far above the base of the South Valley Hill belt (*Hudson River group*) that any resemblance to the gneisses and schists of the lower Schuylkill begins. I think there is no possibility of assigning the rocks of the Philadelphia, Manayunk and Chestnut Hill groups, (the First and Second Belts of Prof. Rogers;) to any place below the slates of the South Valley Hill or Hudson River group. But to what horizon in the Palaeozoic column they belong must remain for the present uncertain.

The Chestnut Hill fault.

A few remarks on the structural conditions existing along the northern edge of the schistose and gneissic belts are here in place.

The northern edge presents a *brush* or sharp synclinal folding. This in itself is a strong proof that the schists are more recent than the rocks upon which they rest ; against which they have rubbed, in subsiding, with such force as to have had their edges upturned.

Fig. 1.



Suppose we have a mass of strata A and B through which a break occurs at FF. The mass **B** descending and the portion A becoming elevated, the beds C and D, for example, have a tendency to assume the portion indicated by the dotted line C′ and D′. This then is a parallel case to what we find throughout this district, along the junction of the schists (B) with the Laurentian (A), the *Third* Belt, as well as with the Potsdam sandstone.

"Fault" is a very indefinite term. There has undoubtedly been some movement along the junction, but how much cannot yet be determined. There is unconformability to be taken into consideration, as well as simple faulting. The condition of the old ocean floor was probably not different throughout this region from other sections of the ocean at that time. The old syenites and feldspatic rocks of the Third Belt (Laurentian) formed prominences, possibly islands or areas of land through this region or east of it. The Palaeozoic rocks were deposited between these promentories, and shoaling rapidly in many places.

The limestones which are found only in a few places along the south side of the Laurentian Belt may never have been deposited to any great distance to the southeastward. I can see no reason why we should expect to find the entire Palæozoic column in this southeastern region of the State, undisturbed and in regular order as it is found further inland towards the northwest.

The disturbance which marked the close of the *Hudson River group* is more strongly indicated the further east and north we go. These disturbances must have been brought about by great changes in relative levels of different portions of the sea bottom. The scene of maximum disturbance must have been along the ancient coast line of the Atlantic now represented, in part, by the Delaware River from Trenton to Chester. In Middle Pennsylvania nonconformability on any considerable scale is almost unknown.

The topography of the district.

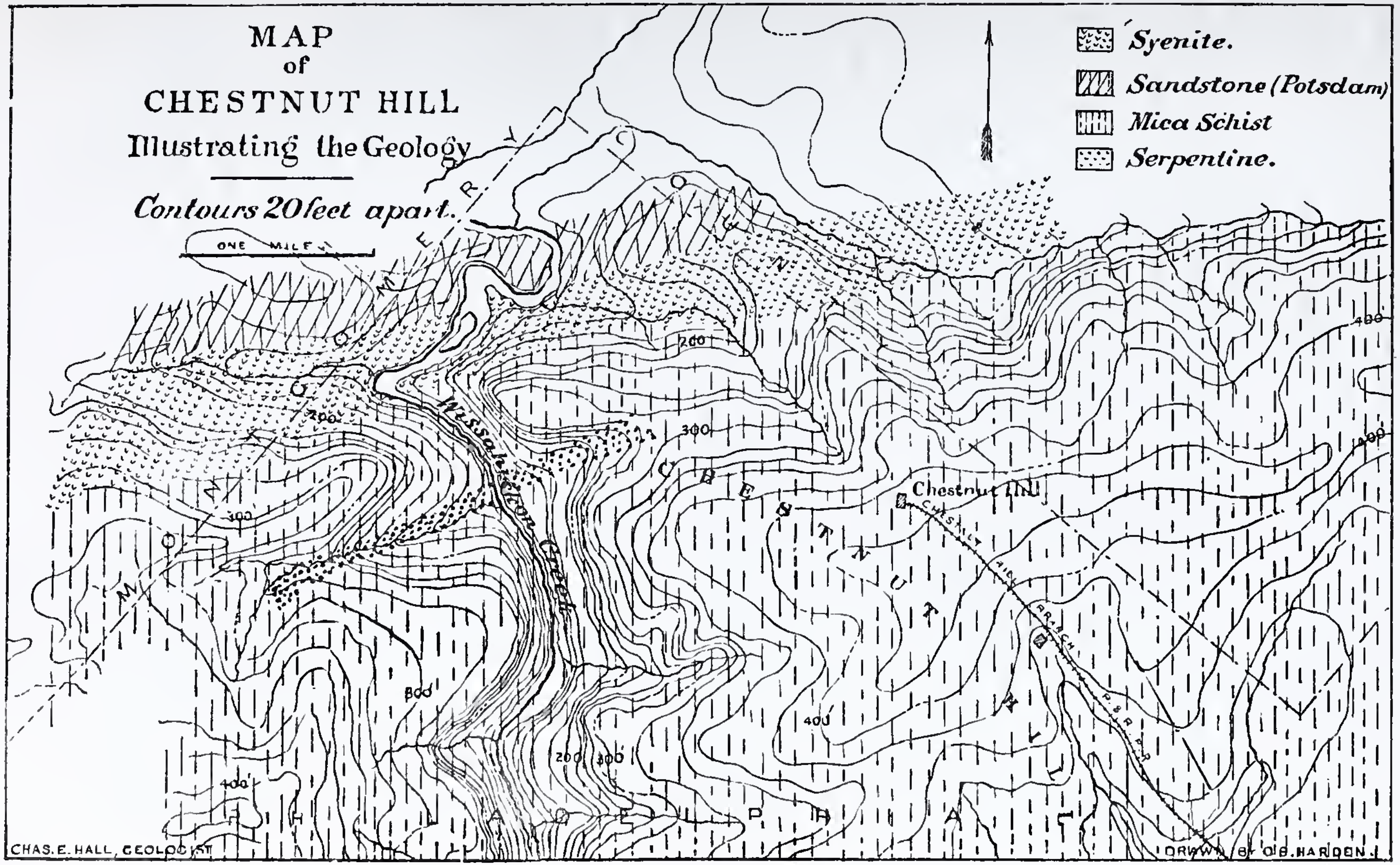
The topography usually is a guide throughout this southeast district of Pennsylvania. The different belts of rock lying side by side are of variable hardness and durability and their junctions are usually pretty well defined.

The contours on the accompanying map, Fig. 2, are taken from the Water Department map of Philadelphia.

The map shows the *junction of the schists of the Chestnut Hill group* resting against the syenites of the Third Belt (Laurentian) and the Potsdam sandstone flanking the syenites on the north.

Although the limits of the different groups are most ob-

FIG. 2.


MAP
of
CHESTNUT HILL
Illustrating the Geology
Contours 20 feet apart.
ONE MILE
Syenite.
Sandstone (Potsdam)
Mica Schist
Serpentine.
Wissahickon Creek
Chestnut Hill
200
300
400
800
CHAS. E. HALL, GEOLOGIST
DRAWN BY O. B. HARDEN.

scure just here, the contours show the relative amount of erosion.

The schist belt at this point forms an exceptionally high ridge.

The serpentine which is shown on this map, crosses the Wissahickon creek west of Chestnut Hill. The depression in which it is found is caused by the soft and rapidly decomposing steatite slates.

On the geological map of Pennsylvania of the First Survey the Azoic group bears a single color. The distinction of *Belts* defined in Prof. Rogers' text is not represented on this geological State map of 1858; so that, unless one is familiar with the region it is exceedingly difficult to follow the writer. For convenience I have reproduced that portion of the geological map which covers the District here in question. (See Figure s, on page 21.)

The vertical lining indicates the whole Azoic area, in which is included the gneisses and schists of the *First* and *Second Belts* and the syenites and feldspathic rocks of the *Third Belt.*

The *Primal*, which extends across the map from the Delaware river to the Delaware county line and flanks the *Auroral* (altered) limestones of the Chester-Montgomery County valley is in reality not continuous, and is not recognizable west of the Schuylkill river south of the south edge of the *Auroral limestones* of the valley in the South Valley Hill.

The rocks of the South Valley Hill, west of the Schuylkill, were considered by Prof. Rogers as equivalent to the Primal of the North Valley Hill; but in the preceding pages I have demonstrated that they must *rest upon the Auroral*, and are of *Hudson River* age.

In like manner south of Abington I have not been able to prove the existence of the Primal; but, on the contrary have demonstrated that limestones rest directly upon the syenitic and feldspathic rocks of the Third Belt (Laurentian.)

The Primal belt crossing the map is considered by Mr. Rogers to be a synclinal basin. This must be an error; and I give proof to the contrary. This proof rests on the structure, which will be seen in my cross-sections.

His prolongation of the Primal rocks, east of the end of the Auroral area, I have not been able to substantiate. Although there is a complication of folds, which renders their distinction somewhat obscure, they do not extend as far east as the Pennepack creek.

The general outline of the alluvial deposits, which are left white in figure 2, are the same as those indicated along the Delaware River on my large colored geological map. Comparing figure 2 with the large colored map the differences will be readily seen.

The succession of the rocks which I propose to demonstrate in this report will be better understood by referring to the following tabulated arrangement, which corresponds to the "Explanation of Colors" on the large colored geological map. (See page 14.)

It will be seen that the slates of the South Valley Hill take us to the top of the *Upper Cambrian*, (of Sedgwick, *Lower Silurian* of Murchison, *Hudson River* formation, No. III.)

The barrier of Laurentian rocks cuts off the connection, if there be any, between these South Valley Hill slates and the schists and gneisses of the the southern belt. It is not fair to presume that these schists and gneisses are a continuation of the Hudson River group. The slates and schists of the South Valley Hill are only a portion of this group, and inasmuch as they are not all represented in this district I have drawn the upper limit as a dotted line in the diagram. The schists and gneisses of those groups following, which in all probability belong to one Palæozoic subdivision, may possibe Silurian or even Devonian.

The Oneida Conglomerate which overlies the Hudson River group and forms the base of the Silurian (of Sedgwick, *Upper Silurian* of Murchison) throughout Pennsylvania does not seem to exist in this part of the State; neither has any trace been yet found of a formation which would be equivalent to the Oriskany sandstone indicating the beginning of the Devonian system.

RECENT.			Delaware River gravel and clay.	Alluvium. Trenton gravel. Philadelphia clay. Red gravel. Yellow gravel. Bryn Mawr gravel.	
CAINOZOIC.			Wealden clay.		
MESOZOIC.			New Red Sandstone formation.	Slate. Sandstone. Conglomerate.	
PALÆOZOIC.				Chestnut Hill group of garnet. schists, serpentines and gneisses. Manayunk group of schists and gneisses. Philadelphia group of schists and gneisses.	METAMORPHOSED.
	CAMBRO-SILURIAN.	No. III.	Hudson river group.	Slates and mica schists of the South Valley Hill.	
		No. II.	Trenton group.	Slate and limestone alternations.	
			Calciferous group.	Marble and Magnesian Limestones.	
		No. I.	Potsdam Sandstone of the North Valley Hill.		
Laurentian system.				Syenites, and granites, feldspathic and hornblendic.	

CHAPTER 2.

Delaware River gravels and clays.

In order to better understand the arrangement of the gravel and clay deposits extending across the southern end of Bucks and Philadelphia counties the general geological structure of the present south bank of the Delaware must first be understood.

The Delaware river flows in a southeast direction from Easton to a point a short distance below Trenton, where it turns and flows southwest to and beyond Philadelphia. This bend is a right angle, and is caused by the river impinging here against the low hilly outcrop of the Cretaceous formation of New Jersey, extending from near the city of New York to the head of Delaware Bay, at Wilmington, in Delaware.

The Delaware river has cut into this formation north of Trenton and, flowing against the barrier formed by the edge of the Cretaceous measures, has worked its way to the ocean along the line of junction, between the Cretaceous and the underlying crystalline rocks.

The Cretaceous originally extended some distance north of its present outcrop limit, and the river must have formerly flowed along a line (in general parallel to its present southwest course) some distance north or northwest of its present channel. Thus, we have some very slight evidence of its once flowing diagonally across the lower portion of Lower Makefield township, and the south-east corner of Middletown township, in Bucks county, following a course defined on the map by the general northernmost occurrence of the *yellow* and *red* gravel.

The limits of the Trenton gravel define a course which the river may have had at a comparatively recent date.

The small patches (north of the limit of the alluvial deposits) called Bryn Mawr gravel by Mr. H. C. Lewis, are possibly remnants of the Upper Cretaceous, or perhaps of the overlying Tertiary measures.

Alluvium.

The mud and fine sand deposited by the river at the present time is found in numerous places along the banks of the Delaware. It is principally confined to the marshes and lowland immediately adjoining the river. It forms a considerable portion of the extreme southern end of Philadelphia, between the Delaware and Schuylkill rivers, and extends west of the Schuylkill across Province island to Darby creek.

Trenton gravel.

This gravel extends along the Delaware from Yardleyville above Trenton to Darby creek below Philadelphia. It is usually a coarse gravel.

Between Morrisville, opposite Trenton, and the vicinity of the Poquessing creek, through the northern edge of Bucks county, there are two sets of terraces and escarpments visible.

The northern escarpment extends along the general course of Jordan Rock run and Mill creek to the neighborhood of Bridgewater.

The southern series of escarpments is marked by the general course of the Pennsylvania canal from Morrisville to Bristol.

These escarpments mark an earlier course of the river.

Yellow and Red gravel and Philadelphia brick clay.

This series forms a broad belt extending from the limits of the Trenton gravel northward to the higher ground. Numerous patches mark the limit of the Cretaceous as it originally existed. This gravel is composed of the débris of all the geological formations which exist along the course of the Delaware river, as well no doubt as the débris from the sands and conglomerates of the edge of the Cretaceous (and perhaps Tertiary) undermined by the river.

Large angular blocks of sandstone and quartzite are found in many places.

The deposit of clay seems to be in many cases interbedded with the gravel. West of the Pennsylvania Hospital for the Insane, west of the Schuylkill river, there is a large area of clay. It is also found in many places east of the Schuylkill along this range. Whether it be derived from the wash of the Cretaceous beds, or a deposit similar to the *glacial clays* of the Hudson river, or whether it had its origin from both sources is still a question. Its age is unquestionably not remote from the *glacial period.* The material which forms much of the gravel with which the clay is associated owes its transport to glacial agencies. Whether the ice did or did not extend to this latitude may still be questioned; but I think there is little question as to the period when the angular blocks were brought south and deposited here with the gravel.

Fragments of fossiliferous rock have been found in various places. They are of unmistakable Oriskany sandstone and Helderberg slate.

Bryn Mawr gravel.

It is not possible for me to say what this gravel may be. I suggested it might be Tertiary or Upper Cretaceous. I believe Mr. Lewis has found it to exist only above a certain elevation, (400′ A.T.) It is found in several places in Delaware county and the location would seem to point to the fact that it is in some way connected with the newer deposits of New Jersey.

Iron-bearing clays.

Through the Chester-Montgomery county limestone valley we find extensive deposits of clay, and associated brown hematite iron ore. These clays are in many cases derived from the decomposition of micaceous slates associated with the limestones. These will be mentioned in connection with the groups in which they belong.

Besides the clays which occupy the position originally maintained by the rock from which they are derived, there is a clay deposit which rests unconformably upon the underlying limestones and seems to occupy eroded depressions. This clay may be directly derived from the clay formed by the decomposition of the slates.

The *Iron-Bearing clay group* is placed (in the vertical scheme of colors on the map) above the Wealden. It will be born in mind that the color assigned to this group is found in the Chester-Montgomery county limestone valley, and at Brownsville, Bucks county, and includes all brown hematite (*limonite*) iron ore-bearing clays, whatever their origin.

Those iron-ore deposits which flank the Potsdam sandstone are all of Potsdam age.

Many of the deposits east of Potts' Landing are probably of Trenton or Hudson River age.

Chapter 3.

Wealden clay.

In the southeastern part of Falls Township, Bucks county in the extreme southeastern corner of the map, there is a small area of clay exposed. This is a remnant of the lowest clay beds of the New Jersey Cretaceous (Wealden ?) The clay is capped by gravel and forms a prominence known as Turkey Hill.

The exposures are confined to the flanks of this hill. It is surrounded by alluvial deposits. The area colored is in the main hypothetical. There is however reason to suppose that the northern limit of the clay extends as far northwest as is indicated on the geological map, from the fact that it appears opposite the points on the river on the New Jersey side.

The course of the Delaware river in this vicinity clearly demonstrates the fact that the stream has been gradually cutting under the edge of the newer formations of New Jersey, which at one time reached as far north as the alluvium, and probably north of the limit of the Bryn Mawr gravel.

Trap.

A trap dyke crosses through Upper Merion, White Marsh and Springfield townships, Montgomery county. It crosses the Schuylkill river at Conshohocken.

It extends in a nearly straight line from the county line, southwest of Mechanicsville, a short distance north of Gulf creek, to Flourtown in Springfield township. East of Flourtown it has not been traced continuously. There are exposures of loose blocks of trap however in several localities extending in a northeast direction from the last exposures of the main belt at Flourtown. The first and nearest to Flourtown is about half way between Sandy Run and Flourtown.

The small map, Figure 4, page 23, shows the location of the trap bowlders found in Upper Dublin township. The line A B is a continuation of the general course of the trap dyke between Flourtown and Conshohocken. The line C D is drawn through the bowlder exposures which are shaded on the plate. The two lines A B and C D form an angle of thirty-two degrees.

The southern margin of the New Red sandstone is a short distance east of Sandy Run and is indicated by a dotted line.

The evidence is that the trap extending from Flourtown into Delaware and Chester counties is of the same age as the trap extending across the New Red sandstone area.

West of the Schuylkill River this dyke cuts through the slates of the South Valley Hill, approaching the southern edge of that group of schists near the Delaware county line.

The dyke does not seem to mark any line of disturbance. It may occupy a fissure crack, along which no lateral movement has taken place.

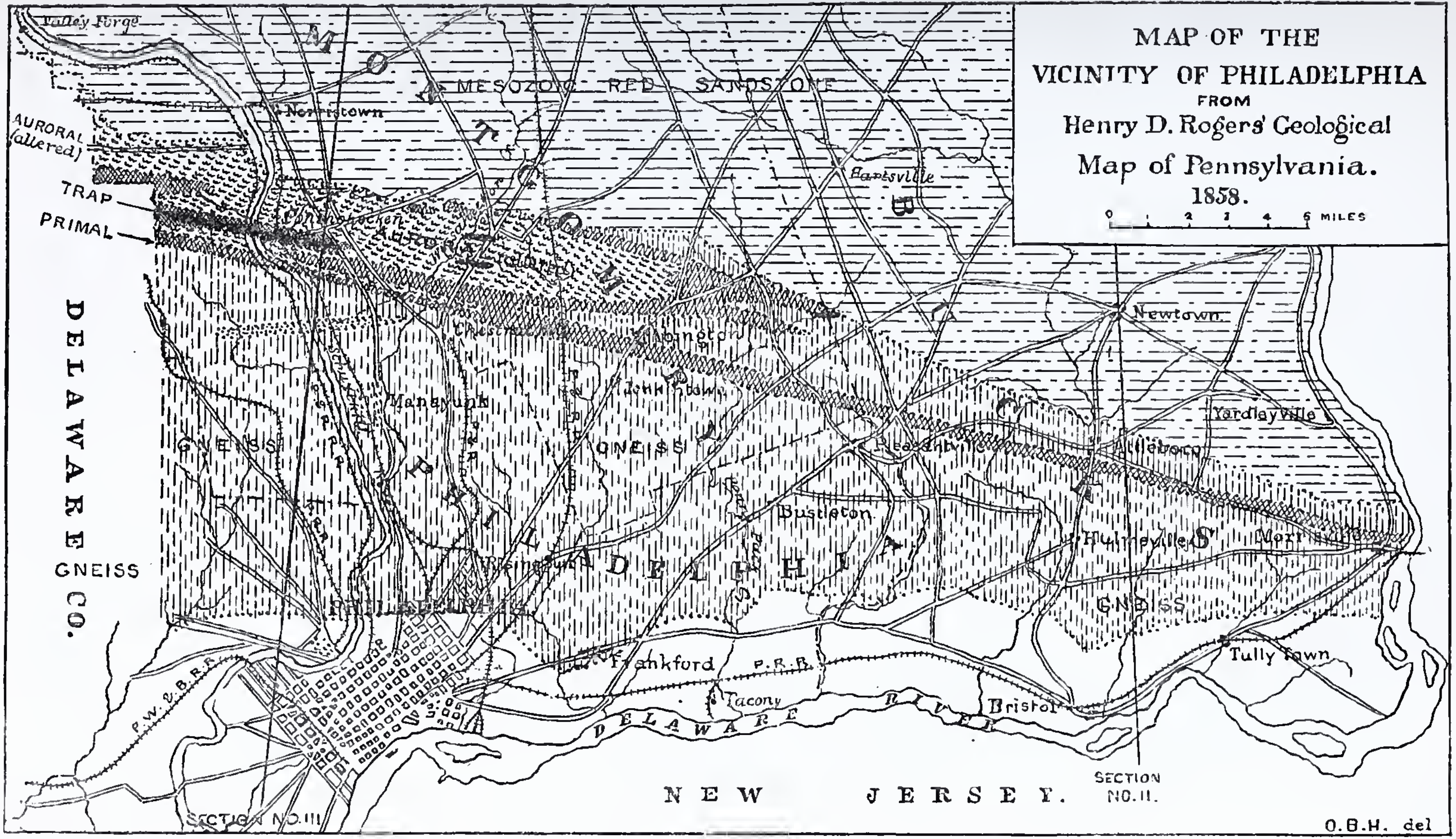
Loose bowlders of trap are observed east of the eastern end of the Chester-Mongomery county valley, along the road leading from Morgan's Mills to Shelmire's mills, south of a rivulet which crosses the road.

Analysis 7789 was made from a specimen taken on the line of section H, south of Gulf Mills and west of Mechanicsville, Upper Merion township, Montgomery county. The analysis compares very well with others made of the same rock from the vicinity of New Hope, Bucks county, which will be found under numbers 5063 to 5086.

Mesozoic (New Red) sandstone.

This formation flanks the metamorphic rocks on the north. It extends from, the Delaware river at a point about half way between Yardleyville station and Morrisville, westward to Valley Forge. Its boundary is more or less sharply defined by streams and escarpments. The larger the streams the greater the escarpments; and consequently the boundary of the formation is more sharply defined along large *streams*. Through Lower Wakefield township the boundary is not

FIG. 3.


MAP OF THE
VICINITY OF PHILADELPHIA
FROM
Henry D. Rogers' Geological
Map of Pennsylvania.
1858.
0 1 2 3 4 5 MILES
Valley Forge
MESOZOIC RED SANDSTONE
Norristown
Hartsville
AURORAL (altered)
TRAP
PRIMAL
DELAWARE
GNEISS
CO.
Newtown
Manayunk
GNEISS
Yardleyville
Attleboro
Bustleton
Hulmeville
GNEISS
Frankford
P.R.R.
Tacony
Tully Town
Bristol
DELAWARE RIVER
P.W. & B.R.R.
NEW JERSEY.
SECTION NO.II.
SECTION NO.III
O.B.H. del

well defined. Through Middletown and to the center of Southampton township however its limit is marked by the Neshaminy creek and Mill creek and a tributary of the Neshaminy which enters it from the east below Bridgetown. Through Moreland township the branches of the Pennepack creek define the boundary. At Morgan's Mills however the New Red sandstone extends some distance south of the Pennepack and flanks the syenite (Laurentian) hills, which rise abruptly south of it. Through Upper Dublin township the escarpments are not sharp ; the boundary ,defined on the map, is however in a few places defined by the color of the soil. This is occasionally the only guide we have.

Between the Delaware river and a point southeast of Dreshertown the Mesozoic rests upon and overlaps the syenites (Laurentian.) From Dreshertown westward to Valley Forge, the Potsdam sandstone and limestones of No. II are found south of the Mesozoic, the syenites not appearing on the north side of the limestone valley.

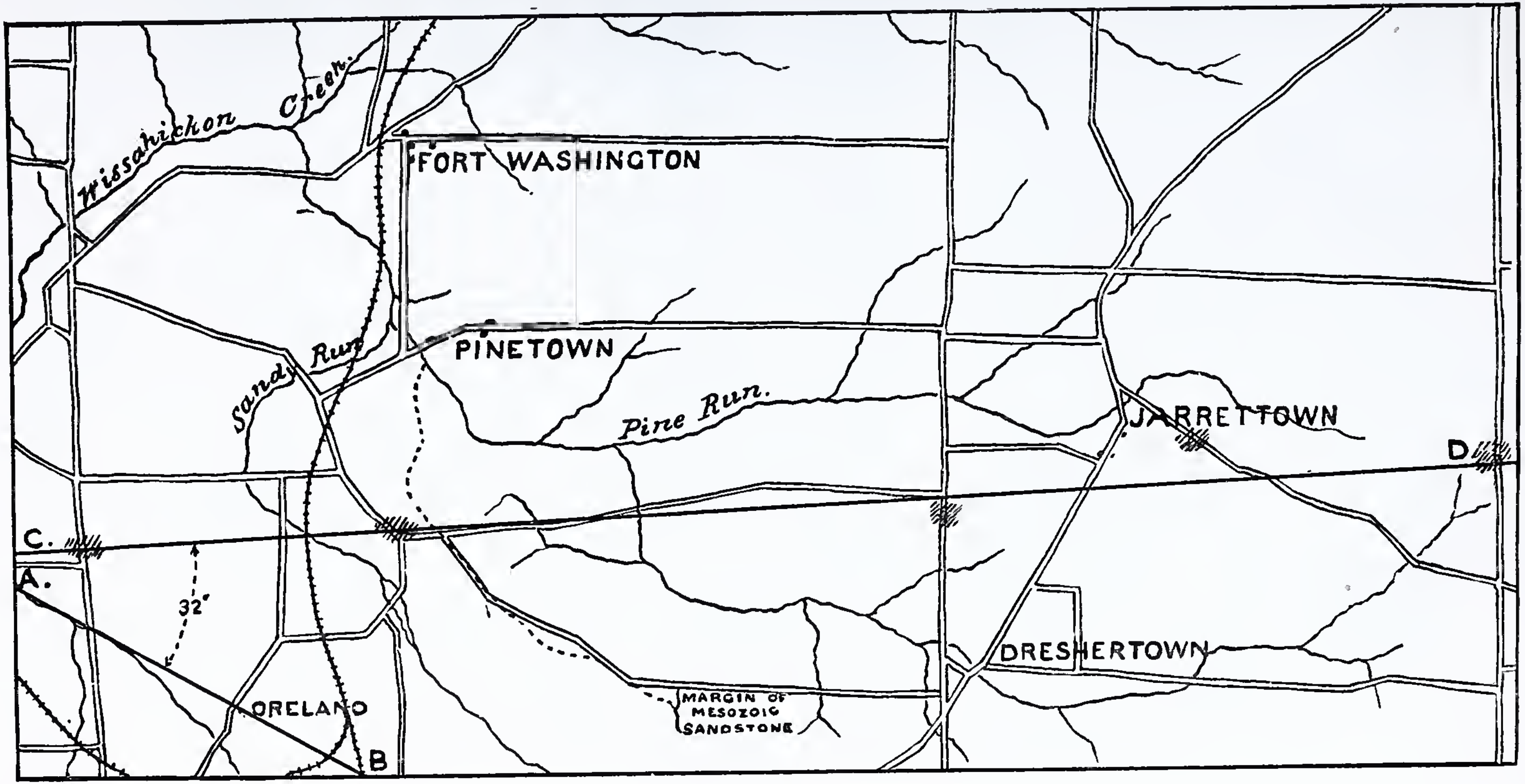
The boundary of the Mesozoic sandstone is very irregular. This is due to the irregularity of the floor upon which it was deposited. It was originally somewhat further south than its present line.

West of the Schuylkill river and west of Bridgeport, there are two islands of the formation, south of the main body. These have been separated by erosion, which has cut through the sandstone to the underlying formation.

In the neighborhood of Henderson station on the Chester Valley railroad there is a deposit of loose conglomerate and sand which in the main resembles the Mesozoic, but I am inclined to think owes its origin to a secondary source. It seems probable that the Schuylkill river, at an early date, worked its way diagonally across the limestone valley from the neighborhood of Port Kennedy southeastward. The line would pass east of the King of Prussia, south of Henderson station and enter the present channel above Conshohocken. If this be the case the débris in the vicinity of Henderson station would be derived from the edge of the Mesozoic, and be composed of the conglomerates and sandstones of that group. This fact cannot be demonstrated

FIG. 4.

MAP SHOWING THE PROBABLE CONTINUATION OF THE TRAP DYKE NORTHEAST FROM FLOURTOWN.



without a carefully surveyed topographical map, which has not yet been made.

The Mesozoic is composed of conglomerate, sandstone, slate and shale. The predominating color is red or rusty-gray.

The conglomerates seem to be local in character, being derived principally from the metamorphic rocks in closest proximity.

At Morgan's Mills the conglomerate is made up of fragments of the syenites (Laurentian) and Potsdam sandstone and conglomerate, which overlies the syenite a short distance south of that place. At Fort Washington the conglomerate is composed of fragments of the Potsdam, which flanks the Mesozoic on the south. The color of the conglomerate and sandstone varies from a light-grayish color to dark-red. The shale is usually red. The soil derived from the decomposition of the rocks of this group, is usually red.

There is often considerable feldspar in the conglomerates and sandstones.

The surface of the metamorphosed rocks south of the margin of the New Red sandstone is usually higher than that of the uppermost beds of the latter group, and the topography no doubt presents somewhat its original aspect, although modified by erosion.

The only trace of organic life noticed along the margin of the New Red is a seam of coal less than an inch thick, in Geo. Justice's quarry, about two and a half miles above Morrisville, in Lower Makefield township, Bucks county. Abundance of animal and vegetable remains have been found at a horizon near the middle of the group, at Phœnixville and elsewhere, though not along the margin.

Analysis 4975 was made from a specimen of conglomerate from Justice's quarry, Bucks county; but in my opinion little can be gathered from analyses of a rock of this character.

Chestnut Hill Group.

This group flanks the syenite (Laurentian) belt on the south. Its extent is rather indefinite. It extends from the vicinity of Chestnut Hill to the Delaware county line at

Bryn Mawr. The northern edge of the group is sharply defined, except for a short distance north of Chestnut Hill. West of the Schuylkill river a serpentine belt marks the north boundary.

Usually there is a marked depression or escarpment between this group of soft schists and micaceous sandstones and the hard syenitic rocks to the north of it.

East of Chestnut Hill the Potsdam sandstone forms the north boundary of the schists. Between Chestnut Hill and the Delaware county line the syenites are found flanking the schists on the north. The southern boundary of the schists is not sharply defined, and it is somewhat doubtful whether there is any line of division between this group and the Manayunk belt.

West of the Schuylkill river Mill creek seems to be a natural boundary; but east of the river the boundary indicated on the map is to a great extent hypothetical. The garnetiferous schists of this group are very similar to the schists of the Manayunk group, and the boundary is not definite. The rocks along the northern edge are slaty micaceous sandstone or gneissic slates. Hornblende is not uncommon, though usually not in thick or massive beds.

East of Chestnut Hill garnetiferous schist and gneiss predominates. This garnetiferous character extends along the northern edge of the schistose-gneissic group, as far east as the Neshaminy creek. It will be seen from the colors on the map that the three belts apparently converge to the east towards the northern edge of the belt.

The structure of the Chestnut Hill belt is clearly synclinal. The southeastward dips along its northern edge are to be seen along the Schuylkill river above Lafayette station and elsewhere. The northwest dips are exposed south of Lafayette and at other points.

The serpentines and steatites are a characterizing feature of this group. They are apparently a key-rock, or definite horizon guide to geology, within this district. Although the rock in many places is almost vertical, there is some slight inclination, and always to the northward along the *southern belt of serpentine*, and to the southward along the *northern belt.*

The southern belt of serpentine extends from Chestnut Hill to the Delaware county line, crossing the Schuylkill river below Lafayette station. It has not been proven to be a continuous belt; and the color indicates the steatite or (serpentine,) where its existence is beyond dispute. This range or belt of serpentine belongs, undoubtedly, to one horizon, although the deposits may be in lenticular masses.

The northern belt of serpentine extends from a point a short distance east of the Schuylkill river to the neighborhood of the Delaware county line, north of Bryn Mawr. This belt seems to be a repetition of the southern belt, being on the north side of a synclinal basin.

East of the Schuylkill the extent of the outcrop is not definitely known. The outcrops designated are the only ones positively known to exist. If there were no faulting along the northern edge of the belt, between the Schuylkill and Chestnut Hill, the northern and southern belts ought to join at the eastern end of the synclinal basin; but they apparently do not.

The synclinal structure is not confined to this group, but extends all along the northern edge of the schists and gneisses, as far east as the Neshaminy creek and probably to the Delaware river; for the structure is not different where other formations than the Laurentian flank the belt on the north, as, for example, east of the Pennepack creek.

Analysis 7288 is taken from a specimen collected at Prince's quarry.

The analyses under this number are Talcose chlorite slate, Chlorite slate, Pyrophyllite and Dolomite. The analyses of Enstatite and "a chloratic mineral" are from Rose's quarry. This quarry is located on the northern edge of the mica schists and on the serpentine belt which flanks the Laurentian on the south, north of Lafayette, on the west side of the river.

The analyses made from specimens collected along the northern edge of the mica schist belt, are as follows: Along the line of section B, Nos. 4632. 4654, 4708, 4752, 4771. On Section D, 5526, 5530. On section E, 5929.

The magnesian rock on the Neshaminy creek, at Flushing, is analysis No. 4949.

The analyses above mentioned are all made of specimens resembling in lithological character the rocks of the Chestnut Hill belt, but it is doubtful whether the belt extends as far east as the location of some of these specimens.

Manayunk Mica Schists and Gneisses.

It will be seen by the map that this belt crosses the Schuylkill river at Manayunk. It extends along the Schuylkill river from the indefinite line indicated south of Mill creek to the mouth of the Wissahickon creek.

Its northern boundary is not a defined line, as the schists and gneisses seem to merge or fade into the varieties of mica schist and gneiss which are characteristic of the northern belt.

Its southern limit is equally obscure.

The northern edge of the schist belt from Jenkintown to the Neshaminy is characterized by garnetiferous schists and occasional hornblendic slates, similar to those along the Schuylkill towards the northern edge of the Manayunk group; and the color on the map is carried eastward as far as the Neshaminy Creek on account of this lithological resemblance.

The belt widens westward, and is shown on the map as extending from the vicinity of Haddington on the south and to Ardmore on the north.

Probably the most marked character of this belt is the weathering of the rock. The color of the weathered rock is usually iron rust yellow or brown. This is especially the case where the Hornblendic slates occur.

The dip is generally to the northward though there are numerous undulations visible along the creek escarpments and railroad cuttings.

Fig. 5.

Alternations of Micaceous and Hornblendic Gneiss, above Shoemakertown, Cheltenham Township, Montgomery County, Pa.

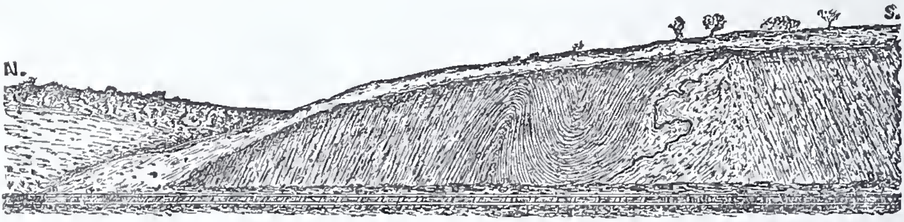


Figure 5 exhibits one of the minor folds along the North Pennsylvania railroad above Shoemakertown. On the south side of the cut the dip of the rock is indefinite. The synclinal and anticlinal structure exhibited seems to be of local character. The rocks are hornblendic and micaceous gneisses.

Philadelphia Mica Schist and Gneiss Group.

This belt of gneisses and schistose rocks extends from the Delaware river at Trenton, westward, across the Schuylkill river, into Delaware county.

The southern boundary of the group is not defined. The Delaware river, however, cuts along the southern edge of the belt as it is known to exist. The newer formations of New Jersey rest upon these rocks.

The northern edge of the belt is to some extent hypothetical. The gneisses of this belt merge or fade into those of the middle belt, and no line of division can be expressed.

The line of boundary designated on the map, however, is located where the gray feldspathic, micaceous gneisses of Philadelphia merge into a more schistose micaceous variety characterizing the Manayunk belt.

The dip of the rock throughout the belt is to the northward, though there are numerous minor folds and contortions observable in all sections of the belt.

There are numerous fractures and faults which add to the complications. Some of these fractures seem to have had no effect on the adjoining bedding, (see Fig. 6,) while along the lines of others the beds are bent and twisted, (Fig. 7.)

Fig. 6.
Fault in Micaceous Gneiss, Old Quarry below Columbia Br. Phila.

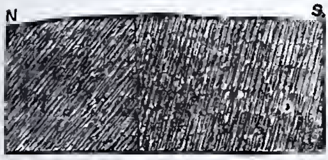


Fig. 7.
Fault and contortion below Columbia Bridge, Philada.

It will be seen that in Fig. 6 the rocks on the two sides of the fracture stand at different angles. There does not seem to be any disturbance in the immediate vicinity of the crack itself. In Fig. 7 the bedding of the rock ascends towards the line of the crack from both sides. In Fig. 6 the rock stands at a high angle, while in Fig. 7 they lie at low angles.

The deduction from these facts would be that the disturbance along the immediate line of fault is dependent upon the relative angle of the fault to the bedding of the rock. Thus if a fault be vertical and the bedding of the rock be vertical there would be no evidence of movement. In Fig. 7 there has evidently been lateral pressure, but no evidence of any great amount of vertical movement.

These two cases are cited as illustrations. There are, however, hundreds of similar occurrences throughout the belt.

West of the Schuylkill river, about the center of West Philadelphia, we find a curious alternation of Hornblendic gneiss with Micaceous gneiss. The dip of the rock seems to be to the westward. The structure is complicated by breaks and fractures, and there seems to be no solution of the relative order of the mass.

Fig. 8.
Alternations of Micaceous and Hornblendic Gneiss, Forty fifth and Walnut Streets, Philadelphia.

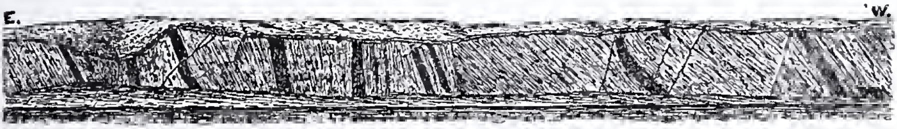
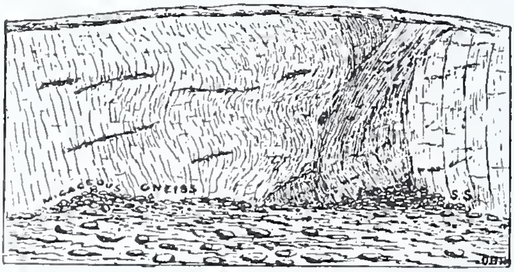


Fig. 8 illustrates the succession of Hornblendic and Micaceous gneisses. This was the appearance of the cut some years ago. The face has since then been cut back some distance and the aspect considerably changed.

Near the eastern end of the cut, Fig. 8, will be observed a fracture which has caused a slight movement in the Hornblendic bed. Fig. 9 is an illustration of this fracture as it appears now. A triangular wedge of this Hornblendic rock remains on the east side of the break, and its continuation on the west side is only just visible above grade level. A small fragment of the Hornblendic rock is detached, and is wedged in between the Micaceous rock about half way between the ends of the Hornblendic bed. The movement here has been about ten feet.

Fig. 9.

ALTERNATIONS OF MICACEOUS & HORNBLENDIC GNEISS
FORTY FIFTH & WALNUT STREETS WEST PHILA.



It will be readily understood from these few illustrations, how difficult it is to determine the equivalency of any of the beds within the area.

Hornblendic slates and gneissic rocks are more frequently met with in this southern belt than to the north. They do not however seem to be confined to any particular horizon, and they have not been traced any great distance from northeast to southwest. The principal localities of hornblendic gneiss are along the Schuylkill river at Columbia bridge, and at a locality about an inch on the map above the bridge. There are numerous other localities east and west of the river, but it has not been proven that they are continuations of these belts which cross the river.

The rocks of this belt dip to the northward throughout the entire area with few local undulations; the dip varying from thirty to fifty degrees.

The analyses of the rock of this belt are Nos. 4795, 4878, 4900, section B; Nos. 5540, 5555, 5572, section D; and 6101; the Eustatite of Flushing school-house, No. 4949. The occurrence of this magnesian rock at Flushing seem to be local; and this is the only locality within the belt where such a rock is known.

South Valley Hill Mica Schists.

[*Hudson River Group.*]

This group of slates and schists is found in the southern portion of Upper Merion township, Montgomery county. It crosses the Schuylkill river in a narrow belt, and extends into Whitemarsh township. Its eastern limit is indefinite.

These slates and schists form a prominent ridge (flanking the Chester county limestone on the south) called the South Valley Hill, and hence their name.

The rocks of this group extend westward to and beyond the Susquehanna river.*

A short distance west of Gulf Mills the South Valley Hill divides into two spurs. The northern arm or spur ends northeast of Gulf Mills. The southern spur extends to the Schuylkill river at West Conshohocken and is also found east of Conshohocken.

The structure of the South Valley Hill in the vicinity of Gulf Mills is a double synclinal. See Fig. 10. The north spur of the hill is encircled by limestone and slate alternations, apparently of Trenton age.

The anticlinal fold which separates the northern from the southern spur, extends to a point a short distance west of Gulf Mills. There seems to be a synclinal depression on the crest of this anticlinal fold, which forms a prominence of slates between the two branches of the brook which flows into the mill dam at Gulf Mills.

[* In the reports on Lancaster and York counties they have been considered by Prof. Frazer, as by Prof. Rogers, as *underlying* the great limestone formations of southern Pennsylvania, No. II. In this report Mr. Hall gives an elaborate series of facts going to show that they *overlie* the limestone, as Mr. Rogers' assistant of 1836, the late Prof. John Frazer, always contended that they did.—J. P. L.]

Fig. 10.

Section from Henderson Station through Gulf Mills, Upper and Lower Merion Townships.

The south spur of the South Valley Hill belt is a synclinal, cut off along its southern side. It rests against the syenite (Laurentian) belt. There is undoubtedly an unconformity between the formations (see Fig. 10); but the line drawn between the syenite and the schistose slates may or may not be the line of a fault.

The rock is generally a quartzose mica schist. There are occasional beds of sandstone and quartzite found with the mica schists, and the whole group was considered by Mr. Rogers as equivalent to the Potsdam sandstone or altered Primal; but a glance at the accompanying section (figure 10. will convince the reader that the structure proves it to be of more recent date than the limestones of No. II.

West of the Montgomery county line, near the southern margin of this group, we find garnetiferous mica schists. These mica schists resemble, in many respects, some of the Manayunk schists south of the syenite belt. I do not intend to assert that they belong to the same horizon, although there may be some such relation between the two belts of rock.

East of the Schuylkill river there is an area of slates extending to the vicinity of Marble Hall. It is principally confined to the south side of the *trap dyke*, and seems to be a continuation of the south arm of the South Valley Hill. Between Spring Mill and West Conshohocken it is flanked on the south by limestones. Between Spring Mill and Barren Hill its southern limit is not clearly defined; it, however, seems to rest against the Potsdam sandstone. The blue-lined area on the map between it and the Potsdam is hypothetical.

The eastern extremity of this belt of slates is indefinite, as indicated by the color on the map. There are exposures between Marble Hall and Barren Hill and along the road between Marble Hall and Spring Mill.

Iron ore is found in the vicinity of Marble Hall within the area of these slates; and there are ore deposits west of West Conshohocken, along the southern edge of the belt. These ores are the result of the decomposition of the slates and schists. From their position it would be concluded that they belong somewhere near the base of the group. Brown hematite ore also occurs north of Gulf Mill, along the road leading to Henderson station. The ore bank is at the base of the slates, close to the edge of the underlying (Trenton) formation.*

Between Potts Landing and Harmansville there is an extensive deposit of clay carrying large quantities of Limonite, and extending eastward beyond Marble Hall.

A synclinal flexure crosses the Schuylkill river at Potts Landing. This fold passes northwestward between Henderson station and Bridgeport.

The probability is that some of the clay and Limonite east of Potts Landing is formed by the decomposed slates of the Hudson River group resting in the synclinal basin of limestone.

These clay and Limonite deposits are indicated on the map by dots upon the limestone. The reason for so indicating them was, that they have not been classified; and that all of the iron ore clay is shown in this way. The belt of Limonite clays extending west of the Schuylkill river, south of Matsunk and Henderson station may owe its origin, in part, to a sharp synclinal fold in which the decomposed slates of the Hudson River group rest. The analyses of the rock are to be found under Nos. 7704, 7733, 7773, and 7214, 7220, 7234.

Slate and Limestone alternations. [*Trenton.*]

The lateral extent of the rocks assigned to this group, is indefinite. The alternations of slate and limestone flank

* This is very instructive, because it brings these ore deposits into analogy with the Ironton ore banks in Lehigh county, and others in Middle Pennsylvania.

the slates of the South Valley Hill on the north, and form the southern limit of the Valley (Magnesian) limestone. The marble is probably the line of division between the lower limestones and the Trenton group. The distinguishing features of the group are the thin bedded limestones and alternating slates. The limestone is usually micaceous. The slates, when weathered have a silvery appearance. Usually there is a considerable amount of iron pyrite disseminated through the mass.

Along the south side of the South Valley Hill the rocks of this group do not appear, or at least they have not been identified.

I consider that the group marks a transition between the limestones and the overlying mica schists.

Magnesian Limestone and Marble.

[Limestones of No. II.]

These are the limestones of the Chester county valley.

The distribution of the limestones is somewhat irregular.

The synclinal trough in which the limestone is comprised, is traversed by minor folds, which extend in a diagonal direction across the axis of the main folding. This structure may be readily understood by referring to the large map, or to the figure showing the distribution of the Potsdam sandstone.

From the Chester county line the limestone belt extends through Upper Merion, Plymouth, White Marsh, Springfield, Upper Dublin, and Abington townships in Montgomery county; its lower strata along the northern edge of the belt, resting upon the Potsdam sandstone of the North Valley Hill or over-laid by the Mesozoic sandstone. The main belt extends eastward to a point about half way between Fitzwater town and Willow Grove.

East of the Schuylkill river there are two well defined synclinal basins flanked by the Potsdam sandstone.

West of the river a synclinal basin extends to the northwestward between Bridgeport and Henderson station and like those east of the river, is flanked on both sides by the

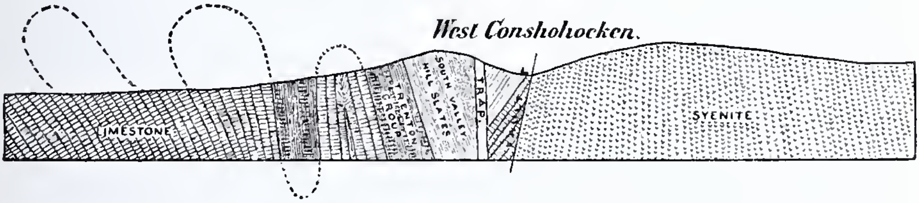
Potsdam. This fold crosses the Schuylkill river at Potts Landing and is visible in the exposures along the river bank. The apparent great widthof the limestone belt along the Schuylkill and east of the river, is due the folding of the measures.

Owing to the scarcity of exposures I found it impossible to locate the exact axes of these folds, and they are there fore not indicated on the map; but in Fig. 14 (1), three of these axis are indicated by dotted lines.

The southern margin of the limestone area is more complicated than the northern side. By considering the South Valley Hill slates equivalent to the Potsdam sandstone, the structure becomes simply an unbroken synclinal; but as we have seen that the slates of the South Valley Hill are in all respects different, and were deposited, under different conditions from those existing during the Potsdam age, upon the limestones, it is not possible to consider the top of the limestone their base, and the structure is not so easily explaned by a simple fold. The south side of the limestone area between Spring Mill and its eastern extremity, however, is really bounded by the Potsdam sandstone; so that this portion of the area *is* a synclinal basin. But from Spring Mill west to the Chester county line the Potsdam has not been identified on the south side of the limestone.

Fig. 11.

Section along the Schuylkill River through W. Conshohocken, Upper & Lower Merion Townships.



The Laurentian flanks the Hudson River slates on the south, except in the vicinity of Conshohocken, where the limestones rest against it. The Hudson River slates cover the southern edge of the limestones. Fig. 11 is taken on the line indicated by G[1] on the map, and shows the relative position of the limestone, slate and syenite (Laurentian) belts.

The probable explanation of the structure is that there is an unconformity as well as a fault between the Laurentian and the Cambrian (Cambro Silurian) rocks.

In the area between Spring Mill, Barren Hill and Marble Hall there seems to be indicated a nonconformity between the slates and the Potsdam Sandstone.

Fig. 12.
Section through Conshohocken & Spring Mill along Schuylkill River; White Marsh Township.

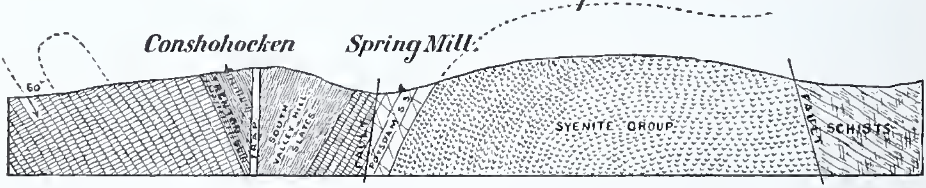


Fig. 12 shows the relations of the rocks along the line of section G. ·In the figure the Potsdam is bounded by a fault, which may or may not in reality exist.

At Spring Mill the limestone seems to rest directly upon the Potsdam. West of West Conshohocken the Potsdam does not exist and the limestone rests directly upon the Laurentian (syenite).

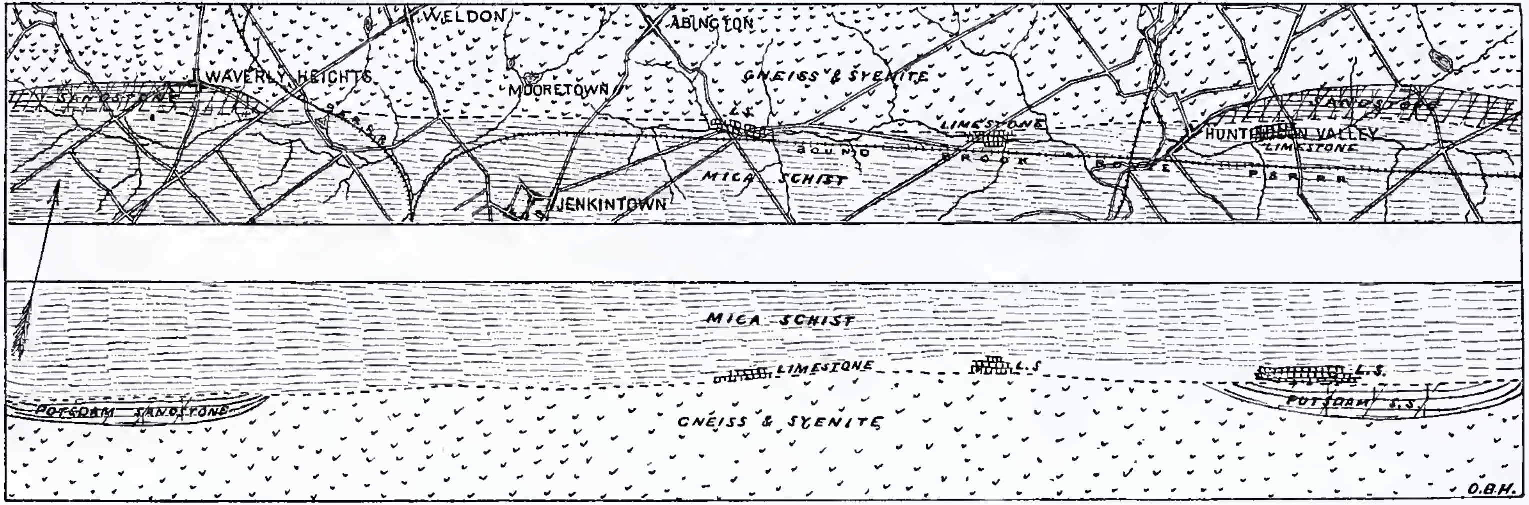
Some of the beds of limestone west of the Furnace at West Conshohocken are mixed with débris of the Syenites; this character seems to be local. There is little doubt however of an unconformity between the Potsdam and the syenites, and there is here proof of portion of the syenite (Laurentian) having been exposed during the deposit of the limestones.

South east of the eastern extremity of the limestone valley, we find a limestone on the south side of a Laurentian anticlinal which passes through Weldon and Abington, Abington township. At Huntingdon Valley this limestone rests upon the Potsdam sandstone. Between Huntingdon Valley and Mooretown it rests directly upon the Laurentian; the Potsdam either having been eroded prior to the deposition of the limestone, or the Laurentian having formed a prominence over which the Potsdam sandstone was not deposited.

The accompanying Figure (13) is taken from the geological map. The rocks stand nearly vertical and the map can

FIG. 13.

MAP & SECTION OF THE SYENITES, POTSDAM SANDSTONE, LIMESTONE & MICA SCHIST BETWEEN HUNTINGDON VALLEY & WAVERLEY HEIGHTS, MONTG'Y. CO.



therefore be viewed as a cross section from east to west. It will be seen that the Potsdam curves slightly southward at Huntingdon Valley and at Waverly Heights. The thickness diminishes and the formation disappears. The limestones rest upon the Potsdam at Huntingdon Valley and seem to overlap the edge of the Potsdam unconformably.

At Spring Mill the same state of things seems to exist. The absence of a formation at any particular place is not necessarily proof of the existence of a fault. The ocean bed through this section of country was uneven and the crystalline rocks, probably in many places, projected above the surface of the water. This was indicated by Prof. Rogers long ago.

The thickness of the limestone in the Chester-Montgomery county valley is a difficult question to answer. The probability is that it is not far from two thousand feet thick; but it may be much less.

The analyses of the limestones have the following numbers: along section F, 6132, 6133, 6143, 6145, 6147, 6149; along section G, 7106, 7109, 7124, 7143, 7159, 7169, 7170, 7171, 7174, 7181, 7187, 7206, 7222, 7225; on section H, No. 7701.

Potsdam Sandstone (Rogers') Primal.

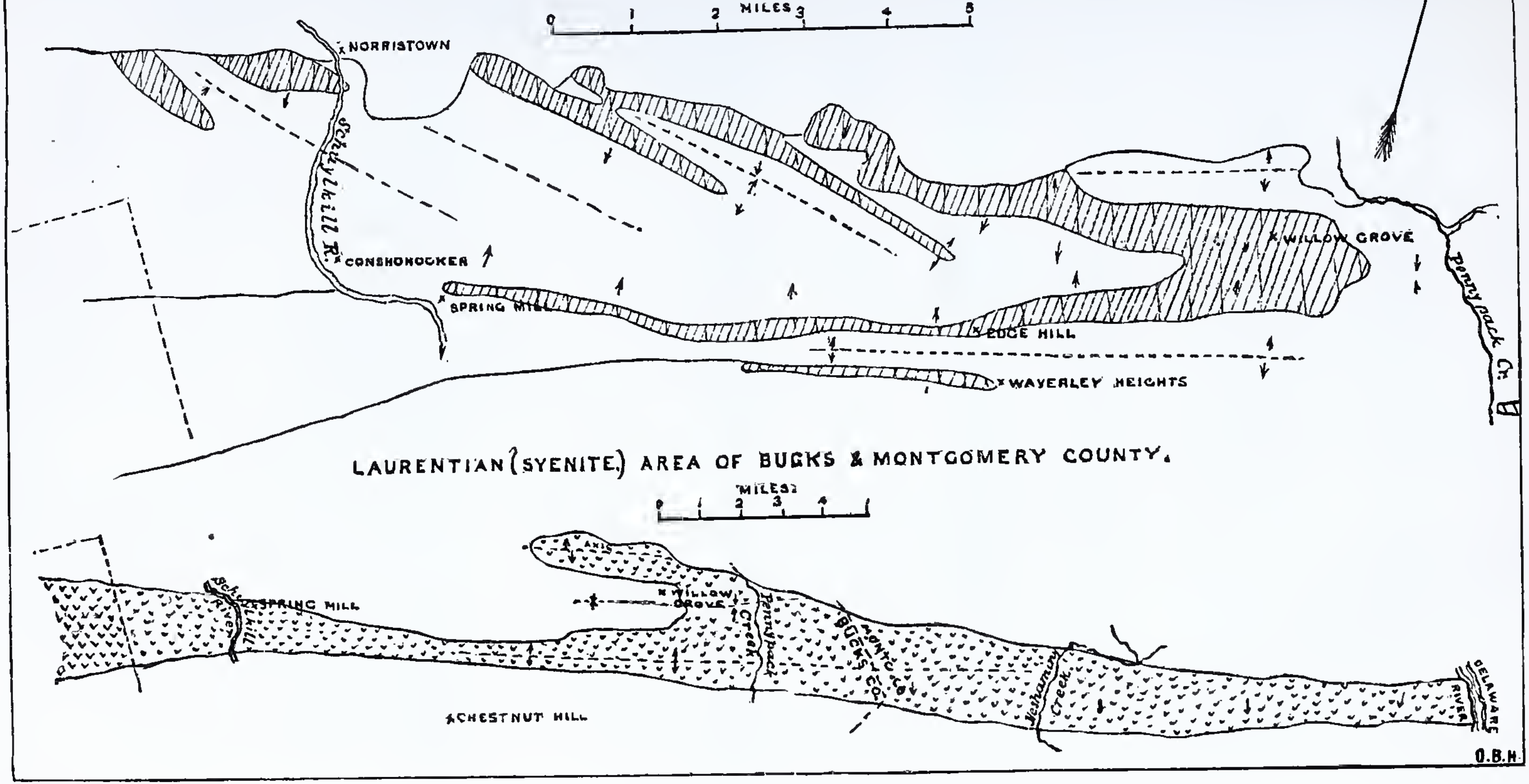
(*Synonyms: Edge Hill Rock; Eurite; Itacolumite.*)

The sandstones, quartzites and conglomerates belonging to this horizon, extend in an unbroken belt from the Delaware river, at the Trenton 'city bridge,' to Huntingdon valley, in Montgomery county. Between Huntingdon valley and Abington station on the North Pennsylvania railroad, the rock is not found. The belt continues, however, from Waverly Heights to the vicinity of Chestnut Hill. The range may be considered as a unit, inasmuch as the break is a short one and the structure the same to the east and west of it.

Fig. 13 represents the conditions between the two points above mentioned. This entire belt of Potsdam flanks an anticlinal fold of Laurentian (syenite) on the south.

The principal exposures of the Potsdam are found flank-

Fig. 14.


POTSDAM SANDSTONE AREA OF MONTGOMERY COUNTY.
MILES
0 1 2 3 4 5
NORRISTOWN
Schuylkill R.
CONSHOHOCKEN
SPRING MILL
EDGE HILL
WILLOW GROVE
WAVERLEY HEIGHTS
Pennypack Cr.
LAURENTIAN (SYENITE) AREA OF BUCKS & MONTGOMERY COUNTY.
MILES
0 1 2 3 4
AXIS
WILLOW GROVE
SPRING MILL
Schuylkill River
Pennypack Creek
BUCKS CO.
MONTG. CO.
Neshaminy Creek
DELAWARE RIVER
CHESTNUT HILL
O.B.H.

ing the limestone valley on the north, between Valley Forge and the eastern extremity of the limestone basin, east of Fitzwatertown, encircling the eastern end of the valley, and flanking it on the south, as far west as Spring Mill.

The distribution of the formation is given in Fig. 14, (1).

The belt extending from Huntingdon valley to the Delaware river is not shown, except its western extremity at the Pennepack creek.

Comparing this area with that assigned to the Primal in the map borrowed from the Report of 1358) Fig. 3,) it will be seen that there is quite a difference in the shape now given to it.

The belt extending from the Delaware to the Pennepack creek, or Huntingdon valley, is flanked on the south by mica schists, except in the vicinity of the Pennepack, where the limestones overlie it. This belt of Potsdam forms the south boundary of the syenite belt (Laurentian) upon which it rests. The Potsdam usually forms a ridge which is recognizable, although it is subordinate to the syenite ridge as, in many places, west of the Bristol Mill creek, in Middleton township. The rock is subject to local contortion, and it is impossible in many cases, to decide what the true dip of the rock is.

The 'surface creep' is strongly marked in nearly all the exposures. It is invariably to the southward along this belt; so that a cursory glance at the surface-dips would lead an observer to conclude that this 'Itacolumite' belt *underlay* the syenites which flank it on the north.

Figure 17 shows the face of a quarry in Southampton township, Bucks county. The depth of the creep here is eight or ten feet.

This belt of Potsdam has been considered hitherto a synclinal ;no doubt the idea was partially derivedfrom misleading dips. It is evident from cross-sections that the belt is a monoclinal.

Section A crosses the Potsdam belt at its eastern extremity.

The belt flanking the Potsdam on the north is the syenite belt which extends across the district the Delaware county line. The rock flanking the Potsdam on the south, at the 'city bridge', opposite Trenton on the Delaware river, is rather different in appearance from anything found elsewhere.

Fig. 15 represents the Delaware river section (Section A.) The *fault* may be simply nonconformity. The southern margin of the Potsdam is left indefinite throughout. The drift and débris renders it impossible to determine accurately the latitude of the belt.

Fig. 15.

Section along the Delaware through Lower Makefield & Falls Townships.

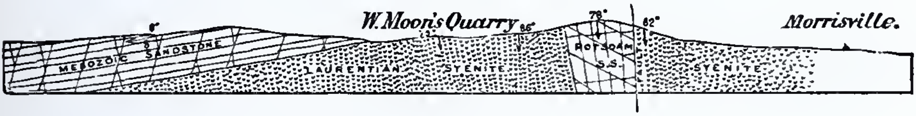
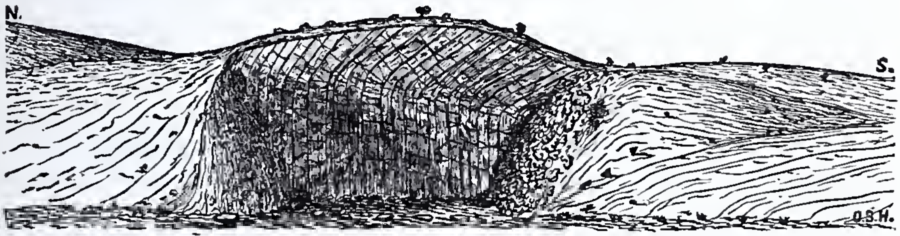


Fig. 16.

Section along the Neshaminy Cr. through Middleton & Bensalem Townships.

Fig. 17.

Quarry of Potsdam Sandstone showing the "Creep" on Knight's Property, Southampton Township, Bucks Co.



Along the Neshaminy creek, (section B,) the Potsdam occupies the same relative position in the syenite belt, but is flanked on the south by unmistakable mica schists. (See Fig. 16.) There is no indication of synclinal structure as indicated in Fig. 25 (1.)

The belt which extends from Waverly Heights to the vicinity of Chestnut Hill is not indicated on the map, Fig. 3. The limits of this belt are not sharply defined. At Waverly Heights it forms a prominent ridge. West of this point its existence is proven by exposures along the roads crossing the belt. The mica schist flanking it on the south encroach upon it and in some places probably extend across the belt and rest upon the syenites.

The Potsdam sandstone outcrops, which flank the limestone valley on the north and extend along its southern side as far west as Spring Mill, afford the best opportunity for studying the formation.

The structure is somewhat complex and seems to have been subjected to two series of foldings.

The main fold seems to be a prolongation of the South Valley Hill synclinal fold while the flexures along the north side of the limestone are at an angle and belong apparently to another system.

The direction of the main fold is about W. 75° E. ; but the axis of the folds along the north side of the Valley are about south 80° east. The probability is that the northwest south east flexures are of earlier date than the north east south west folding. My reason for this conclusion is that we find slight curves or deflections along the Potsdam ridge, (known as Edge Hill,) or the belt which extends from Spring Mill to Willow Grove ; and these curves are opposite the prolongation of the anticlinal and synclinal flexures.

The structure of the belt which extends from Spring Mill eastward is monoclinal. Towards its eastern extremity there may be a complication of synclinal foldings, but I have not been able to prove their existence.

Figure 25 (3) gives the interpretation of Prof. Rogers ; but the sharp synclinal and anticlinal fold in this figure I have not myself demonstrated, and have therefore repeated the structure as a simple monoclinal in Fig. 18.

The dotted line over the limestones indicates that there are folds which have not been determined. In Fig. 25 (3) several folds in the limestone belt are indicated by a dotted line below the section.

Fig. 25 (4) is a section from Morgan's Mill to the west of Yerke's Factory. The Potsdam is indicated by the form of the eastern extremity of the sandstone east of Willow Grove

Fig. 18.

Section from Lancasterville to Chestnut Hill, through Whitemarsh and Springfield Townships to Philadelphia.

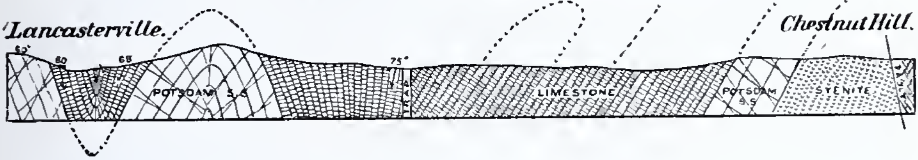


Fig. 19.

Section from Willow Grove to Paul's Brook, Moreland & Abington Townships.

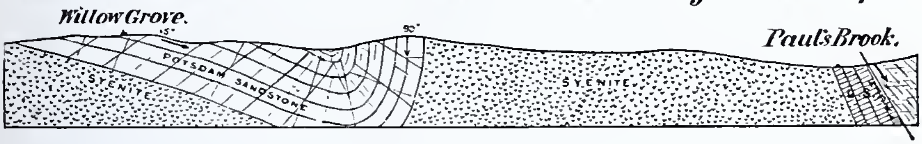


Fig. 20.

Section across the east end of the limestone valley, Abington Township.

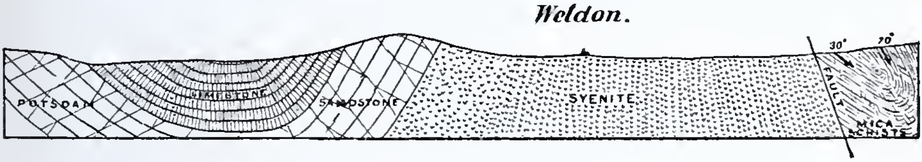


Fig. 21.

Section from Fitzwatertown to Waverly Heights through Upper Dublin, Abington & Cheltenham Townships.

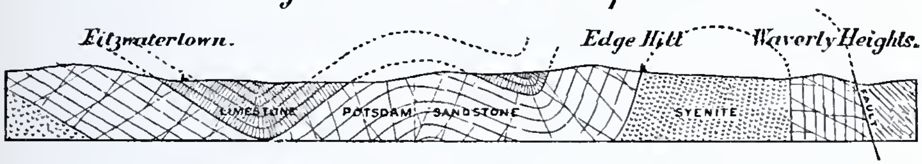


Fig. 22.

Section from Fort Washington to the vicinity of Chestnut Hill.

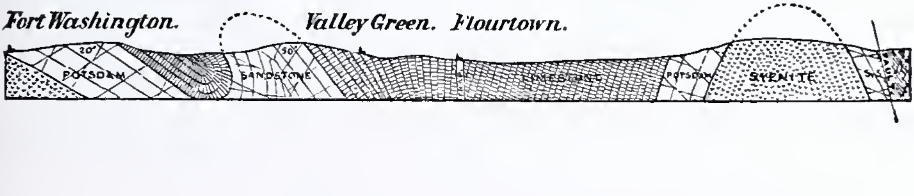


Fig. 14 (1); but, as there is still some question as to the exact structure, it has been drawn as a simple synclinal fold; Section D1.

Fig. 19 is taken on the same line as Fig. 25 (4).

Fig. 20 is on the line of section E. There is a minor contortion in the synclinal basin; and it will be seen from the map that the existence of the sandstone towards the southern side of the valley is questionable.

It will be seen that the Potsdam sandstone does not occur on the south side of the syenite anticlinal in either of the sections, Fig. 19 or 20.

In Fig. 21 1 between Edge Hill P. O. and Fitzwatertown the Potsdam forms a low anticlinal which is the eastern portion of an anticlinal, north of Lancasterville shown in Fig. 22 north of Valley Green.

In the two Figs. 21 and 22 the Potsdam is found on the south side of the syenite (Laurentian) anticlinal.

West of the Pennepack creek the relation of the Potsdam sandstone to the limestone is indicated in Fig. 23.

The synclinal in Fig. 19 would be about opposite Yerkesville.

Fig. 24 gives the structure of the Potsdam sandstone on the north side of the limestone valley at Cold Point on the line of section F'.

This Cold Point anticlinal is shown in Fig. 18, south of Lancasterville, and ought to appear in Fig. 22 at Flourtown, but no proof of its existence.

West of the Schuylkill we find the folds of the Potsdam similar to those east of the river.

The structure of the Valley Forge Potsdam area is not clear, but it seems to be a double anticlinal with the axes parallel to each other, and also parallel to the folds along the north side of the valley east of the Schuylkill river.

The southern boundary of the Potsdam area south of Valley Forge, I have not determined.

The character of the Edgehill rock is somewhat variable, though there is little change along the belts, from the Delaware river to Huntingdon valley, and from Waverly Heights to Chestnut Hill, and in the belt flanking the limestone valley on the south, between Spring Mill and the eastern end of the Edge Hill ridge, south-east of Willow Grove.

It is usually a fine-grained white, or gray sandstone, and quartzite, with scales of light-colored mica. It is usually thinly laminated. Occasional beds of fine conglomerate are met with.

Conglomerates.—Following the belt around the east end of the synclinal at Willow Grove, we meet with heavy beds of conglomerate formed of débris from the syenite. These conglomerates are overlaid by finer sandstones and schistose sandstones or slates.

Fig. 23.

Section along the Pennypack Creek, Moreland Township.

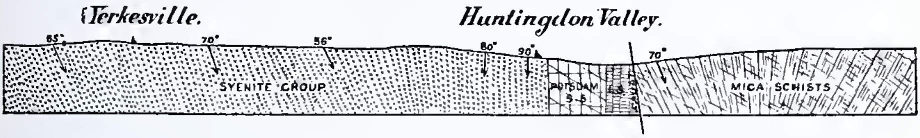
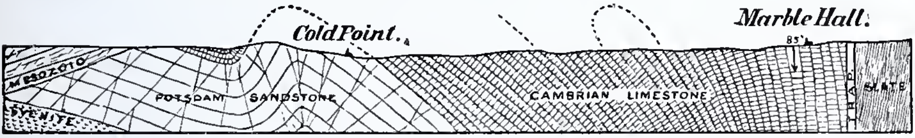


Fig. 24.

Section through Cold Point & Marble Hall, Plymouth & Whitemarsh Townships



These slates are exposed in a cut along the North-East Pennsylvania R.R., below Willow Grove.

It is in this horizon that the brown hematite ore occurs which flanks the Potsdam ridges. The iron ore clay at Brownsville is, undoubtedly, of this horizon. The iron ore deposits encircling the eastern end of the limestone valley, between Edge Hill and Fitzwatertown, belong to this *upper Potsdam slate-horizon.* The iron ore at Oreland, and that developed along the south side of the Hickory-town-Cold Point anticlinal, as well as some of the deposits north of Chestnut Hill, belong to the same horizon.

To the north-west the color of the Potsdam becomes darker, and in some places is of a dull red color, resembling somewhat the color of the Mesozoic sandstone which flanks it on the north.

The difference in color may be partially accounted for the fact that the belts on the south stand at high angles, and the iron oxide stain would more easily be washed out than along the north side of the valley where the rock lies at a lower angle. The coloring matter of the Mesozoic sandstone may also have had its influence upon the underlying rock.

The names *Itacolumite* and *Hydromica* schist have been applied to the specimens analyzed.

Specimens Nos. 4616, 5348, 5892, 5894, 6121 and 6159, belong to the horizon of the Potsdam.

Syenitic and Gneissic rocks.

(*Laurentian.*)

The crystalline rocks of this group extend from the Delaware River, above the Trenton 'city bridge,' to the Delaware county line, west of the Schuylkill River. The belt is flanked on the north by the Mesozoic sandstone between the Delaware River and the vicinity of Dreshertown. The shape of the area is given in Fig. 14, (2.) Between the Pennepack creek and the Delaware the Potsdam forms the south boundary.

Between the Pennepack and Waverly Heights the limestone and mica schists rest against the syenites. The mica schists flank the belt on the south between Chestnut Hill and the Delaware county line. The schists of the South Valley Hill and the limestones flank the group on the north side west of the Schuylkill River. East of the Schuylkill the Potsdam sandstone forms the north boundary to the vicinity of Dreshertown. There are fine exposures along the creeks crossing the belt. The exposures along the Schuylkill river indicate a broken anticlinal. See Fig. 12.

In Fig. 14 (2) a dotted line indicates an anticlinal fold passing north of Chestnut Hill, also an anticlinal axis north of Willow Grove. Besides these there are undoubtedly many other minor folds, but it has been impossible to define them.

The rock is harder than that of the adjoining belts and it consequently forms a prominent ridge. It is known as Buck Ridge between the Neshaminy and Pennepack creeks. The character of the rock is the same as the Laurentian of the Welsh mountain and the rocks of the Durham hills at Easton.

Small particles of *magnetite* have been found in many localities. No beds of this ore however are known within this belt.

At one locality *plumbago* has been found. It is said to have been mined at one time, but there is no indication of its existence in quantity. The old mine is located on A. Johnson's farm, about one mile southeast of Feasterville, north of the road to Brownsville, Southampton township, Bucks county.

Crystaline limestone occurs in a local deposit on Van Artsdalen's farm, west of the Neshaminy creek and southeast of Rockville, in Southampton township. The quarry has long been known to mineralogists.

A variety of gray and red *granite*, on Willard's place, between Somerton and Feasterville, has been used by the railroad company for bridge abutments.

Below the Trenton city bridge there is an exposure of rock of doubtful age.

These are indicated in section A, and also in figure 15. (Analyses Nos. 4409, 4445, 4446, 4452.)

The following analyses of specimens have been made: On section A, 4310, 4351, 4360, 4362, 4371, 4378, 4387, 4388; on section B, 4457, 4458, 4473, from Van Artsdalen's quarry and 4504, 4532, 4539, 4582 from other points along the section: On section C, 5247, 5268, 5277, 5278, 5303, 5304, 5306, 5309, 5311, 5321: On section D, 5469, 5495, 5514, 5526, 5530, 5540, 5555

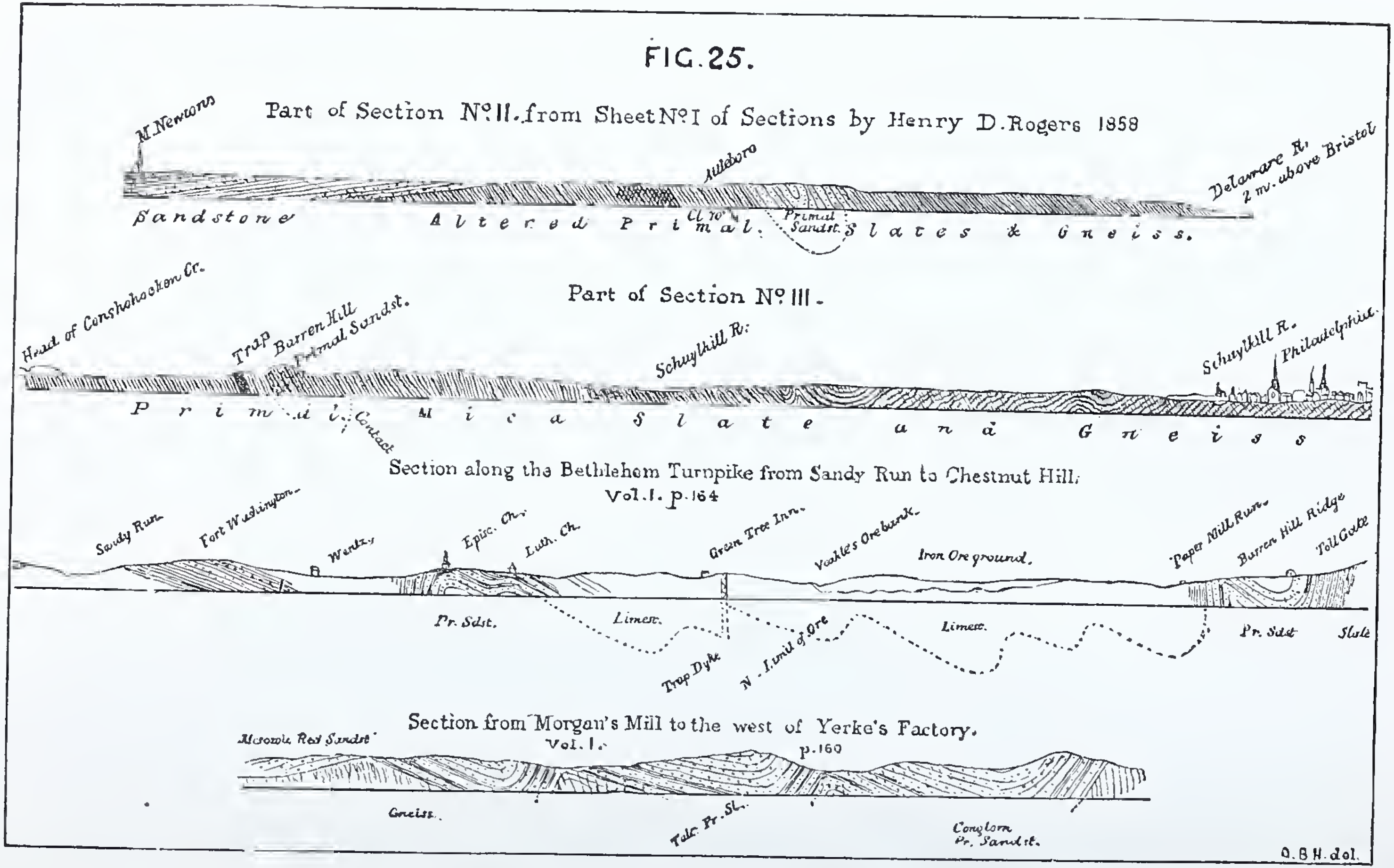


FIG. 25.
Part of Section No. II. from Sheet No. I of Sections by Henry D. Rogers 1858
M. Newtown
Attleboro
Delaware R. 2 m. above Bristol
Sandstone
Altered Primal
Primal Sandst.
Slates & Gneiss.
Part of Section No. III.
Head of Conshohocken Cr.
Trap
Barren Hill
Primal Sandst.
Schuylkill R.
Schuylkill R.
Philadelphia
Contact
Primal Mica Slate and Gneiss
Section along the Bethlehem Turnpike from Sandy Run to Chestnut Hill.
Vol. I. p. 164
Sandy Run
Fort Washington
Wentz's
Episc. Ch.
Luth. Ch.
Green Tree Inn.
Yeakle's Ore bank.
Iron Ore ground.
Paper Mill Run.
Barren Hill Ridge
Toll Gate
Pr. Sdst.
Limest.
Trap Dyke
N. Limit of Ore
Limest.
Pr. Sdst.
Slate
Section from Morgan's Mill to the west of Yerke's Factory.
Vol. I.
p. 160
Mesozoic Red Sandst.
Gneiss.
Talc. Pr. Sl.
Conglom. Pr. Sandst.
O. B. H. del.

TOWNSHIP GEOLOGY.

Lower Makefield Township in Bucks County.

(*Mesozoic Sandstone.*)

The whole of the northern portion of the township is covered by the New Red sandstone. Its southern limit between the Delaware river and the Pennsylvania canal is difficult to define on account of the Alluvial deposits which overlie it. The boundary is however somewhere in the vicinity of J. Demmer's property.

West of the Pennsylvania canal the boundery is tolerably well defined. A ravine or depression on L. Suber's property, south of George Justice's quarry on the west bank of the canal, marks its limit. From this ravine, west, to the township line, it forms almost a straight line. The brook which flows into White's Lake forms an elbow at the line of junction of this group with the syenites which flank it on the south. The boundary crosses the Delaware Branch of the Bound Brook railroad a short distance south west of Palmer station, and crosses the west township line in the vicinity of H. H. Brelsford's house, north of the railroad. The streams are small and there has not here been the amount of erosion we find elsewhere along the edge of this formation.

We find a deposit of gravel in the neighborhood of the railroad along the west edge of the township, which to some extent obscures the limit of the sandstone.

There are numerous exposures of the sandstone and shale along the railroad cuttings. At Geo. Justice's quarry on the west bank of the Pennsylvania Canal, near the southern margin of the formation the dip of the rock is about 5° north 20° west. This may be taken as an average throughout the township.

There is much micaceous red and gray sandstone and red shale.

Potsdam sandstone.

The southern boundary of the township is nearly on a line with the belt formed by this group. Near the canal in the southeast corner of the township, and west of Queen Ann's run in the southwest corner of the township, the Potsdam belt is south of the township line. East of Queen Ann's run the belt passes just south of an angle in the township line.

The rock is a fine grained sandstone with micaceous partings, occasional beds of coarse sandstone and conglomerate, and beds of quartzite.

Tourmaline crystals are numerous, usually quite small, needle like. Cubes of iron pyrite are found in nearly all localities. Cubical cavities are often met with when the rock has been weathered.

Dan. Neeley's quarry is located about the center of the south township line.

There are other exposures of the rock along the belt within this township, but they are unimportant.

Syenite, (Laurentian.)

These rocks form the belt between the southern edge of the Mesozoic sandstones and Potsdam sandstone.

The principal exposures of the rock are along the Delaware below J. Demmer's house and opposite S. Dana's property; also along the Pennsylvania canal on S. Dana's and on Wm. Moon's property.

Falls Township in Bucks county.

Alluvial.

Gravel and river deposits cover the greater portion of the south half of the township. Near the northern edge of the gravel we find terraces and escarpments. These escarpments have a diagonal course across the township. The escarpments mark the successive courses of the Delaware river as it has gradually undermined the Cretaceous beds which are now eroded or concealed below the alluvial, (except at Turkey Hill, in Pennsylvania) but flank the river on the New Jersey side. The course of the river at one time, has been on a line between Morrisville and Tullytown.

Itis a question whether the gravel can justly be subdivided by reference to these different horizons or levels. My opinion is that they are all intimately interlinked, and the change has been a daily one, which began at the time the river first began to undercut the Cretaceous or possibly Tertiary measures.

The gravel is found *upon* the clay of Turkey Hill.

In connection with the gravels and their arrangement in this township, it is well to call attention to the depression in the Potsdam ridge north-west of Morrisville and in the neighborhood of the crossing of Rock run into Lower Makefield township. The Delaware river has possibly a one time crossed to the south side of the Potsdam at this point and worked its way in a north-westerly direction toward Fallsington.

Wealden. (Cretaceous ?)

The southeast portion of the township is underlaid by the pottery clays described in the New Jersey reports. The alluvium, however, covers to a considerable depth. At Turkey Hill there is an area which has withstood the erosion of the river and affords the only outcrop of the Wealden (?) which I know of in the State.

Mica Schists.

It is fair to presume that the mica schists underlie all of the more recent deposits and extend to the neighborhood of the north line of the township and probably as far east as Rock run. Whether they extend southeast of this line is questionable.

There are no exposures anywhere within the township which give any satisfactory data. Much of the surface is covered by a débris formed by the decomposition and breaking up of the underlying rock.

Potsdam Sandstone.

The belt of sandstone extends along the northern edge of the township. It crosses the northeast corner of the township a few yards above the Trenton "city bridge," above Morrisville. At the first angle in the township line, the formation is probably north of the line. West of the center of this line it crosses and recrosses several times and reaches the west township line a short distance above Oxford Valley.

The rock forms a ridge which is quite prominent near the western side of the township.

There are numerous exposures along the belt. The principal quarry is on Pratt's place a short distance west of the "city bridge" above Morrisville.

The rock here is sandstone and quartzite with micaceous layers or partings. Cubes of iron pyrite and small tourmaline crystals are plentiful in some of the beds. They usually occur in the fine-grained sandstone.

Syenite. (Laurentian.)

The area of this formation is limited to two small triangles north of the Potsdam, and a belt south of the Potsdam along the Delaware river from the vicinity of the "City Bridge" to the upper end of the island opposite Morrisville.

The areas north of the Potsdam are in the northeast and northwest corners of the township. These are connected with the main belt flanking the Potsdam on the north. There are several exposures of the rock along the Pennsylvania canal.

The belt south of the "City Bridge" may possibly belong to some other group of rocks than the Laurentian. They are very similar however to those north of the Potsdam sandstone outcrop.

Middletown township in Bucks county.

Alluvium.

There is some gravel to be found in the central and northern portion of the township resting upon the Mesozoic and Laurentian or syenite belt. This gravel seems to extend across Lower Makefield township to the Delaware river.

The southern portion of the township is covered by the river gravel and débris of the decomposing schists.

In the vicinity of Langhorne station there are deposits of gravel and clay which seem to differ in character from the ordinary gravel. The clays associated with this gravel, may be partially due to the decomposition of the micaceous beds which occur in the Potsdam sandstone group.

The gravel and débris conceals the rock south of the Potsdam belt except along some of the brook courses.

Mesozoic.

The northern third of the township is occupied by the Mesozoic.

The south boundary is marked by a brook entering the Neshaminy creek south of Core creek and Bridgetown. East of the head of this brook the boundary is almost a straight line to the east township line just north of the railroad intersection.

Near the eastern edge of the township there are no exposures of the rock. In the neighborhood of the Neshaminy creek however there are numerous exposures. The formation here, as elsewhere, is made up of alternating beds of sandstone, conglomerate, shaly sandstone and shale. The conglomerate and sandstone varies greatly in color, from a pale yellow or white to bark red and gray.

Mica Schists.

The schists occupy the southern portion of the township. There northern boundary is a line drawn from the Neshaminy creek at the confluence of Chub run to Oxford Valley P. O. This is approximately the line of the Potsdam belt.

The only exposures of any consequence are along the Neshaminy creek from Chub run to the township line below Hulmeville. (See section B.)

The rock along the northern edge of this belt is a garnetiferous mica schist. Proceeding southward the garnets gradually diminish in quantity and give place to mica schists with quartz. Alternations of hornblendic slate occur in the garnetiferous belt.

Potsdam sandstone.

The Potsdam enters the township in a narrow belt crossing the east township line north of Oxford Valley, passes through Flowers mill, and curves southward towards Langhorne. From the vicinity of Langhorne to the Neshaminy creek it forms a straight line. It crosses the Neshaminy above the rail road crossing. At this point the Potsdam makes a barrier across the creek and forms what is known as Neshaminy Falls.

There are few exposures in the eastern portion of the township. At Flowers mill there is a quarry worked by the rail road company. Between Langhorne and the Neshaminy creek there are numbers of exposures along the brooks which cross the belt, as well as in the railroad cuttings.

The dip of the rock varies from 80° to 90° where not disturbed by surface dislocation; but in numbers of places along the rail road between Langhorne and the Neshaminy creek the apparent dip of the rock is to the northwest. This I found to be due to the 'creep' or folding over of the upper edges of the rock. The lower beds of the group are quartzite and sandstone. Some of the upper beds are micaceous. The upper portion of the group is softer than the lower beds and therefore occupy the south flank of the ridge. The Neshaminy creek has cut its channel parallel to this belt between Oakford and Club Run.

Syenite. (*Laurentian.*)

The Syenite belt is bounded on the north by the Mesozoic sandstone. Between Bridgetown and the angle in the Neshaminy creek west of Attleboro the Neshaminy marks its limit. The Potsdam sandstone flanks the syenite on the south, along a line across the township from a point north of Oxford valley through Flower's mill to the Falls of the Neshaminy.

Along the course of Bristol Mill creek and in the vicinity of Attleboro there is considerable débris upon the rock, which conceals it from view. This is partially the result of the decomposition of the adjacent and underlying rocks.

Along the Neshaminy creek there are numerous exposures of the rock.

The rock is variable in character. There are some which resemble the garnetiferous feldspathic rock of Wm. Moon's quarry; others are micaceous and resemble some of the mica schists.

Bristol township in Bucks county.

Alluvium.

Nearly the whole of Bristol township is covered with gravel and clay.

Terraces and escarpments are distinguishable south of Emilie P. O. These have a general northeast and southwest course and correspond to those in the adjoining township of Falls. Mill creek marks the course of one of these escarpments, which undoubtedly corresponds to the one marked by Jordan creek and Rock run in Falls township.

The northern portion of the township is covered by a débris principally derived from the disintegration of the underlying rocks. There is considerable gravel along the Neshaminy creek between Newportville and Schenck's station.

Clay occurs in the Laurel Bend neighborhood near the school-house.

Mica Schists.

In the northwest angle of the township, north of Emilie P. O. mica schist is found on Queen Ann's creek. Along the Neshaminy creek exposures of the rock are numerous between the north township line, above Newportville, and Schenck's station, or Bridgewater, on the Pennsylvania Railroad.

On Queen Ann's creek the rock is a coarse crystalline schist, composed of large plates of mica with feldspar and quartz. Along the Neshaminy creek the rock is not different in composition, but usually is more schistose, and the mica occurs in small crystals.

In the vicinity of Newportville the rock is rather more silicious than elsewhere. The rock is much contorted, but usually lies at low angles and pitches to the northward.

Mesozoic.

The sandstones and shale of this group cover the entire area of the township lying north of Mill creek. The Neshaminy and Mill creek form the southern boundary. There are numerous exposures of the rock along the Neshaminy creek. There are also some quarries in the vicinity of Rockville.

The formation is composed of alternations of slate, sandstone and conglomerate. The conglomerates and sandstones are composed of the fragments of the underlying measures. The escarpment formed by Mill creek and the Neshaminy is quite abrupt and the limit of the formation is sharply defined.

Syenite. (Laurentian.)

The triangle formed by Mill creek and the south township line is occupied by the Syenites. At Rockville the Syenites extend north of Mill creek to about the center of the town, where they are capped by the Mesozoic.

There are few exposures of the rock except at Rockville.

The composition of the rock is principally quartz, feldspar and hornblende.

The rock is usually decomposed on the surface to a considerable depth. Fragments of the underlying rocks are found throughout the surface débris

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Southampton township in Bucks county.

Mesozoic.

The northern end of the township is covered by the Mesozoic. The southern boundary is Mill creek and a west branch of the same creek to the center of the township, from which point it has a western course to the township line, at the intersection of the road leading from Southamptonville to Huntingdon valley.

Along Mill creek and its tributary the boundary of the Mesozoic is defined by an escarpment. In the western half of the township, however there are no well defined escarpments, and its limits can in some cases only be defined by the red color of the soil which results from the decomposition of the red shale and disintegration of the sandstone.

Mica Schists.

The schists cross the extreme south-western corner of the township at Pleasantville. They extend to the vicinity of the railroad (D. & B. B. R.R.) Their northern limit is somewhat obscure, there being a broad escarpment between them and the Potsdam ridge.

Clay occurs in this escarpment and may be partially derived from the schists; but I am inclined to consider them as being partially derived from underlying measures. The character of the schists is similar to that elsewhere along the northern edge of the belt. They are garnetiferous mica schists, with occasional beds of slaty hornblendic gneiss.

Potsdam sandstone.

The quartzites and sandstones of this group are found in the southeast corner of the township at Neshaminy Falls; also extending across the southwest corner of the township between Brownsville and the west township line, at the intersection of the road leading from Feasterville to Somerton. Along the southern margin of sandstone there is a defined escarpment. The Syenites flank the sandstone belt on the north. The mica schists extend to within a short distance of the outcrops of the rock on the south.

Along the Neshaminy creek the rock is exposed. The character here is a compact quartzite with occasional beds of decomposing sandstone. Layers of mica form partings in the quartzite.

Near Wynkoop's mill, west of Brownsville, on the east branch of the Poquessing creek, is a quarry on Knight's property. The rock at this place is a fine-grained sandstone, thinly laminated. The quarry shows the 'creep' exceedingly well, the normal pitch of the rock being about 90°. (See Fig. 15.)

There is also a quarry near the west township line on J. W. Willard's property.

Syenite. (*Laurentian.*)

The Syenite group crosses the township in a belt between the Mesozoic and the Potsdam sandstone.

Feasterville is located about the center of this belt, which forms the most elevated portion of country in this section.

The north boundary of the group described as the south boundary of the Mesozoic, viz.: Mill creek and its western branch, and a diagonal to the west township line, at the intersection of the road leading from Southamptonville to Huntingdon valley. From the angle formed by the southwest corner of Northampton township to the Neshaminy creek, the syenites extend northward of the township line.

The south boundary is formed by the Potsdam belt between Brownsville and the west township line. Between Brownsville and Scottsville the rock extends south of the township line. It is flanked however by the Potsdam sandstone in the adjoining township.

There are numerous exposures of the rock along the Neshaminy creek.

North of Feasterville, on Anderson's place, the rock is quarried.

Southwest of Feasterville, west of the road leading to Somerton, a coarse granite occurs on Willard's farm. This has been used for bridge abutments by the railroad company. It varies in color from gray to red. At Anderson's quarry the rock is a thinly bedded slaty syenite. Along the Neshaminy it varies from a gray slaty micaceous quartzite to a hornblendic syenite. East of Feasterville a dark colored hornblendic syenite occurs. It resembles dolerite in appearance.

Plumbago.

Southeast of Feasterville and north of Brownsville, on A. Johnson's farm, plumbago has been mined. It occurs disseminated through the feldspatic and quartzose rock. Some pockets of considerable size have been found, but the quantity is not sufficient to pay for working, and the mine has long since been abandoned.

Limestone.

Crystalline limestone occurs in this township near the Neshaminy creek. It is interbedded with Laurentian rocks and occurs near their northern edge. The quarry, which is worked, is Vanartsdalen's farm. It is well known as a mineral locality. The limestone occurs in the hornblendic gneiss. Plumbago occurs throughout the limestone. The The extent of the limestone seems to be limited to a narrow belt and confined to Vanartsdalen's property. The probability is that it is a lenticular mass and local in character.

Throughout the entire belt there are no other exposures of limestone. (See Genth's report B.) It is unquestionably of the age of the syenite (Laurentian).

Bensalem township in Bucks county.

Alluvium.

The gravel extends over the southern portion of the township. Its northern limit is obscure, but it probably extends as far as Hulmeville and Richelieu. Along the northern margin however it is considerably admixed with débris of the underlying rocks. A narrow belt between the Pennsylvania railroad and the Delaware river may have been occupied by the river at the time it flowed along the general course of Rock run and Mill creek through Falls and Bristol townships. The arm of gravel extending up the Neshaminy creek beyond Newportville is probably not different from the adjoining gravel.

Mica Schists.

The whole of the township south of Oakford and Brownsville is underlaid by mica schists.

There are numerous exposures of the rock along the Neshaminy creek from Oakford to Bridgewater, and from the township line to the Pennsylvania railroad bridge over the Poquessing creek.

The rock along the northern edge of this belt is garnetiferous mica schists. The exposures of this rock are numerous between Oakford and the angle of the Neshaminy above Hulmeville.

South of Oakford hornblendic gneiss occurs, which is also found on the Neshaminy above Hulmeville. Descending the Neshaminy creek the garnet schists gradually disappear, and fade into mica schists of which the principal constituents are quartz, mica and feldspar. Occasional beds of hornblende and quartzite occur throughout the mass.

Below Newportville, at Flushing, on Dr. Taylor's estate, a magnesian rock occurs which Dr. Genth has found to be *enstatite.* It apparently has no structural connection whatever with any of the *serpentines* of Montgomery and Philadelphia county. Its occurance is analogous to the limestone of Vanartsdalen's quarry in Southampton township.

Along the northern edge of the schists the dip of the rock is to the southeast, varying from 70° to 80° degrees. (Section B.) This dip is confined to the northern edge and is universal. There are a number of contortions visible along the Neshaminy creek, and occasional south dips have been observed; but as a rule, the rock pitches to the northward, the angle of dip decreasing as we descend the stream. At Newportville the angle is about 10°. South of this point some dips were obtained which were apparently not reliable and have not been recorded.

The character of the rock along the Poquessing creek is the same as that on the Pennepack.

The cleavage is exceedingly misleading at all the exposures.

Potsdam sandstone.

The Potsdam crosses the northwest angle of the township and extends from the vicinity of Oakford, or Willet station, to Brownsville. A rivulet entering the Neshaminy creek from the west at Oakford marks its southwestern boundary approximately. The syenites flank the Potsdam on the north.

At Willet station there is an exposure of decomposed sandstone which overlies the more compact quartzite of the group. There are few exposures within the township, although the rock forms a prominent ridge.

Syenites. (Laurentian).

North of the Potsdam belt the Syenites occupy a small space within the township limits. They extend northward into the adjoining township. There are no exposures of the rock in this township.

Moreland township in Montgomery county.

Mesozoic sandstone.

The northern end of the township is occupied by the Mesozoic. The southern boundary extends diagonally across the township, following the course of the east branches of the Pennepack to the vicinity of the Byberry road. The Pennepack creek and Heaton creek form the limit between Byberry road and the west township line, except in the vicinity of Morgan's Mills. A short distance below Morgan's Mills the sandstone extends south of the creek and flanks the syenite hills, which rise abruptly to the south, and follows the course of Round Meadow run to a point west of the Northeast Penn road crossing.

There are numerous exposures in the vicinity of Morgan's mills. On the Newtown road, east of the Pennepack creek, sandstone and conglomerate is exposed.

In the railroad cut, north of Round Meadow run, the exposures show shale, sandstone and conglomerate.

The conglomerate is formed of pebbles of Potsdam sandstone and syenite. Throughout the sandstone and conglomerate of this group feldspar is quite common.

All the sandstone and conglomerate along the margin of the Mesozoic seems to be chiefly composed of the débris of the crystalline rocks which flank the group on the south.

Mica Schists.

The area of mica schists is limited to the southeast corner of the township. Its limit is the line of Huntingdon creek and its east branch, a line parallel to and north of the Delaware branch of the Bound Brook railroad.

There are numerous exposures of the rock along the line of the railroad and the roads which cross the belt. The character of the rock is a fine-grained garnetiferous mica schist, with occasional beds of hornblendic gneiss.

The group rests upon the limestone south of Huntingdon valley and probably upon the Potsdam sandstone towards the south eastern edge of the township.

Limestone (No. II).

The existence of limestone is known positively only in one locality, which is on Huntingdon creek south of Huntingdon valley.

It rests on the Potsdam sandstone, and is flanked on the south by the mica schists. The character of the valley, between the Potsdam sandstone ridge and the schists, would indicate the existence of the limestone continuous with those of Abington township. It may also extend eastward towards Somerton station.

Its position places its Upper Cambrian (or Lower Silurian) age beyond doubt. The position of the mica schists prove them to be of subsequent age.

The limestone locality in this township is on Ayer's property. The limestone was found in digging for iron ore, and it is not exposed on the surface of the ground. The fact that this limestone is in precisely the same geological position as the limonite clay of Brownsville may throw some light on the origin of that clay, though I am inclined to assign its origin to the decomposition of the clay beds of the upper Potsdam.

Potsdam Sandstone.

The Potsdam belt which has been traced through the various townships from the Delaware river, passes through the southern portion of this townsihp.

It enters the township near the southeast corner and extends to the vicinity of Huntingdon valley, where it disappears.

Between the southeast corner of the township and Boutcher's mill, on Huntingdon creek, it forms a prominent feature in the topography.

Between this mill and Huntingdon valley, however, it becomes somewhat difficult to trace. Between Huntingdon valley and the west township line the land is low and swampy. The probability is that the belt curves slightly to the southward and is cut off by faulting or nonconformity and overlaid by the limestones and mica schists.

West of Shelmire's mills we find a large area of Potsdam sandstone. It extends along the west township line from a point above Willow Grove to the vicinity of Terwood run; and east to the road leading from Yerksville to Morgan's mills. The boundary is somewhat irregular. It crosses Round Meadow run a short distance north of Willow Grove, curving southward and coming to an apex a short distance east of the Yerkesville road. From this point it curves southward to the vicinity of Terwood run and the township line.

This area is the extreme eastern extension of the synclinal basin of Mongomery county.

Along the north side of this area the pitch of the rock is gentle, while along the south side the angle is high see Fig. 17 (4) and 19.

There are numerous exposures of the rock along the margin of the area, the principal one being east of Willow Grove and know as "The Rocks."

At this point there is an extensive exposure of sandstone and conglomerate. The dip is about 15° to the southward.

All the conglomerate seems to be composed of fragments of the underlying syenite. Large fragments of syenite also occur imbedded in the conglomerate. This fact is proof in itself of the non-conformity of the two groups, and may partly explain the disappearance of the rock west of Huntingdon valley ; see Fig. 13.

Southeast of Willow grove, near the township line and towards the center of the area, the rock becomes shaly and to some extent micaceous. These are evidently equivalent to the upper beds of the group in which the brown hematite ore occurs in many places.

Syenite. (Laurentian.)

This group occupies that portion of the township lying between the Mesozoic sandstone and the Potsdam belt which crosses the southern portion of the township. It extends westward to the west township line, dividing into two arms west of Shelmire's mill, one passing north, the other south of the Willow Grove Potsdam area ; see Fig. 14 (2.)

The Pennepack creek cuts this belt at right angles and affords good exposures of the rock between Shelmire's Mills and Huntingdon Valley.

The rock is a compact quartzose, feldspatic gneiss and Syenite. Some beds contain garnets and mica. At Clayton's quarry, above Huntingdon Valley, the rock is thinly laminated. It usually contains much feldspar. Some of these thinly laminated beds of this group have been altered Primal or Potsdam, which they often resemble.

Upper Dublin township in Montgomery county.

Mesozoic.

The greater portion of the township is covered by the new Red sandstone. Its southern boundary is somewhat irregular. It passes diagonally across the southern portion of the township from the southeast corner to Pine run, at its intersection with the west township line. Pine run forms the boundary for a short distance between the southeast corner of the township and Dreshertown. It crosses the street road and Limekiln turnpike about half way between Dreshertown and the Twining road, and extends diagonally to the Dreshertown road. It lies upon the syenite east of Dreshertown and flanks the Potsdam sandstone of Camp Hill between the street road and the west township line.

There are numerous exposures along the roads of shale, sandstone and conglomerate. The sandstone and conglomerate along the edge of this group is invariably composed of the débris of the underlying crystalline rocks.

A trap dyke crosses the township between Dreshertown and Jarrettown. It may be a continuation of the trap which is found north of Sandy run, along the west township line. (See Fig. 4).

Limestone (No. II).

Sandy run crosses diagonally the south west corner of the township, and marks the north boundary of the limestone area, which occupies this corner. There are numerous quarries and ledges of the limestone in the vicinity of Fitzwatertown.

The principal quarries are on Dr. Potter's, Cannon's, McVaugh's, and Carey's properties.

The dip of the rock varies from southeast to southwest, with a fall of 40° to 50°. South of Sandy run, along the west township line there is still some question as to the existence of limestone. It will be seen from the map that a tongue of Potsdam sandstone may enter this corner of the township. The limestone color (blue) is *lined* to indicate that its existence is questionable.

Potsdam Sandstone.

This group forms a prominent ridge across the southern edge of the township. West of Fitzwatertown this ridge is known as Camp Hill.

The north boundary of the belt is formed by the southern margin of the New Red sandstone extending from the west township line to the vicinity of Dreshertown. Between the Street road and the south township line the boundary is marked by a south branch of Pine creek.

The south boundary is marked by Sandy run. The rock is exposed along the Limekiln turnpike, between Sandy run and Dreshertown, near H. Heist's house. There are numerous exposures along the Street and Hatboro' roads.

Along the southern flank of the belt the beds are shaly and decomposed. Brown hematite ore occurs in them.

It is along the junction of these decomposed slates with the limestone that Sandy run has cut its course.

Along the Street road the rock stands at a high angle.

On the Lime kiln turnpike the dip of the rock does not exceed fifteen degrees (15°.)

Syenite. (Laurentian.)

The syenites occupy a small area in the southeast corner of the township. They extend along the course of Pine run to the vicinity of Dreshertown. The west boundary of the area is the line of the south branch of Pine run to the south township line. There are no well defined exposures of the rock within the township. There is however abundant evidence of its existence along the Twining road, between the branches of Pine run. The character of the débris is similar to that in the adjoining townships. The rock is composed of quartz, feldspar, and hornblende.

The Potsdam caps this group west of the south branch of Pine run and flanks the group on the south.

The syenite forms an anticlinal and is covered by an anticlinal of the Potsdam sandstone at its western end.

Abington township in Montgomery county.

Mica schists.

The southern half of the township is occupied by the mica schists. Their northern boundary is the line of Paul's brook to the vicinity of Mooretown. From this point, it is almost a straight line to the west township line, a short distance below Abington station on the North Pennsylvania railroad. The escarpment facing Paul's brook, is continuous west of this township.

There are numerous exposures of the rock in the vicinity of Jenkintown, along the northern edge of the group and along the Pennepack creek.

The rock along the northern edge is a fine grained mica schist with occasional beds of hornblendic gneiss. To the southward the garnets gradually diminish in quantity and the rock passes into a quartzose mica-schist, with occasional beds of hornblendic gneiss or slate.

The dip of the rock is southward along the northern edge, at angles varying from 30° to 70°. A short distance below Jenkintown the dip reverses, with angles of 80° to 90°. Near the southwest corner of the township the rock is considerably contorted. The dip there is to the northward, at angles from 5° to 50°.

Along Paul's brook the schists rest upon limestone. (See Fig. 19.) West of Mooretown the contact seem to be with the syenites. (Fig. 13.)

Potsdam (Edge Hill) sandstone.

The "Edge Hill" belt crosses the township in a diagonal direction, from Edge Hill P. O. to the east township line, north of Ferwood run, and joins with a north arm of the same group extending across the north-east corner of the township forming a U shaped area.

The south boundary of the belt is nearly straight between Edge Hill P. O. and the east township line.

The rock rest upon the underlying syenites (Laurentian). The syenite flanks the north arm of the group in the north west corner of the township, west of Willow Grove.

The belt, which is quite narrow in the vicinity of Edge Hill P. O., gradually widens to the eastward. The north limit of the south arm is indefinite, as there is no escarpment between the decomposed sandstone beds and the overlying limestones, which are included in the center of the U, or synclinal basin.

The southern margin of the north arm is close to Sandy run. This creek has its source north of Terwood run near the eastern edge of the township and enters the limestone valley about half way between Willow Grove and Fitzwatertown.

Bordering the upper margin of the sandstone, iron ore has been developed. From the location of these ore mines it is probable that they owe their origin to the decomposition of the shaly beds of the upper Potsdam.

East of Edge Hill P. O. there is a marked depression in the Potsdam ridges at the point where the North East Pennsylvania railroad crosses the belt.

There are numerous exposures of the rock along the belt.

At Edge Hill P. O. the North Pennsylvania railroad cuts through several hundred feet of the rock. There is also a quarry east of the railroad at this place. There are numerous quarries and exposures along the Edge Hill road, between Edge Hill P. O. and the east township line.

Along this south arm of the synclinal the rock pitches at high angles, varying from 75° to 90°.

The rock is a light colored sandstone, conglomerate and quartzite with laminae and disseminated scales of mica.

The color of the sandstone is usually nearly white when exposed to the weather. Specular iron (micaceous ore) occurs disseminated through the quartz in some localities.

Towards the eastern edge of the township the character gradually changes and the prevailing rock is dark colored conglomerate, sandstone and micaceous slates, with occasional beds of nearly white sandstone. The slate are exposed at Rubicam station, on the North East Pennsylvania railroad, below Willow Grove.

The pitch of the rock in the northeast portion of the township, and on the north arm of the belt, is much less than along the Edge Hill ridge.

At Rubicam the dip is 5° south; while east of Willow Grove it is only 15°.

The difference in character, or more particularly in color, may be due to the difference in position. Along the south side of the synclinal, the position is such as would expose the rocks to the free percolation of water; and a dissolution of the iron, which colors the rock, would follow; and where it had not been exposed to this action, the coloring matter would remain.

Limestone (No. II).

The limestone area in this township is rather indefinite. Near the northwestern edge of the township, Sandy run bounds the limestone on the north. Towards its eastern extremity however, it extends north of this creek for a short distance. It probably extends along the northwest line of the township, from Sandy run to the vicinity of Edge Hill Furnace. Its southern margin would not be far north of the iron ore developements flanking the north slope of Edge Hill.

The quarries on Elias Kirk's and Mrs. Tyson's properties afford good exposures of the rock. At Kirk's quarry the dip of the rock is 55°, S. 50° E.

Near Edge Hill Furnace, in the northwest corner of the township, there is a small exposure of limestone.

Limestone occurs along Paul's brook at Hollowell's mill and on J. Bradfield's place. This is a continuation of the limestone which is found near Huntingdon valley P. O. in the adjoining township.

The extent of this limestone is not known, but it is continuous from the east township line to the neighborhood of Mooretown and possibly extends to the west township line. At Bradford's place it was found at a depth of twenty-eight feet below the surface. At Hallowell's Mill it may be seen in the bed of the brook.

It lies upon the Syenite group and is overlaid by the mica schists. (See Fig. 13.) Its geological position is proven in the adjoining township where it rests upon the Potsdam sandstone. Along Paul's brook the Potsdam sandstone does not appear, and the limestone resting upon the Syenite would indicate nonconformity between the Potsdam and the limestones, or a prominence of the Syenites which was not covered by the Potsdam.

Syenite, (Laurentian).

A belt of this group crosses the township in a diagonal direction. Abington and Weldon are about the center of the belt.

It is bounded on the north by Edge Hill which extends from Edge Hill P. O. to the east township line.

The southern boundary extends from Abington station to the head of Paul's brook, south of Mooretown; thence along the general course of Paul's brook to the east township line near Huntingdon valley. The belt gradually diminishes in width from the east to the west.

The structure of this belt is anticlinal.

There are numerous exposures along the roads and brooks. The strike of the rock is nearly parallel to the axis of the belt. The rock sands vertical or nearly so.

Cheltenham township in Montgomery county.

Mica Schists.

A diagonal line across the northern end of the township between the northwest corner and the east township line, a short distance below Abington station, marks the boundary of the mica schists. The general course of Taconey creek between the east township line and its course, marks the junction of the schist with the Potsdam sandstone.

The escarpment is sharply defined except near the north west corner of the township.

There are numerous exposures of the rock along its northern edge, and along the course of Tacony creek and the North Pennsylvania railroad throughout the entire length of the township.

The garnetiferous character prevails along the northern edge of the group. Quartzose and hornblendic mica schists prevail throughout the southern portion of the belt.

From Shoemakertown northward the rock pitches vertically, and in many places is much contorted and dislocated. (See Fig. 5).

South of this point the rock is very variable in direction and strength of dip.

In the neighborhood of Ashbourn the dip varies from 20° to 35°.

South of Ashbourn the pitch increases to 50°.

No doubt in some cases, (where the rock is homogeneous), the cleavage has been mistaken for dip.

The surface is generally covered by débris of the decomposed rock. There is some gravel along the southern and western portion of the township.

Limestone (No. II).

Limestone probably occurs in the northeast corner of the township south of Edge Hill furnace. There are however no exposures of the rock within the township boundary, and its existence may be considered doubtful.

Potsdam Sandstone.

There are two belts of Potsdam sandstone crossing the northern end of the township. The southern belt flanks the mica schist group on the north, and extends from Waverly Heights to the northwest corner of the township. The north belt is the western end of Edge Hill and extends across the northeast corner from Edge Hill P. O. to the center of the north township line.

The southern belt forms a prominent ridge at Waverly Heights, which rapidly dies away to the west; and the rock can only be recognized in a few places between Waverly Heights and the northwest corner of the township. There are numerous exposures at Waverly Heights. The mica schists rest upon, and against this belt.

The north belt forms a prominent ridge near the east township line. To the westward this ridge gradually subsides.

The rock is a quartzite, and white and gray sandstone, usually thinly bedded. Specular iron (micaceous ore) occurs in small quantities through some of the beds. Mica is found throughout the sandstone.

Syenite. (Laurentian.)

The syenite belt is quite narrow and extends along the east township line between Abington station and Edge Hill P. O. It is flanked on the north and south by the Potsdam sandstone and extends beyond the north township line, west of the center. There are few exposures within the township limits where the rock is to be found. It is a thinly bedded syenite. The southern limit is not sharply defined west of Waverly Heights, on account of the débris of the mica schists and the soft character of the Edge Hill rock along this margin.

There is a possibility that the mica schists rest directly upon the syenites in some places west of Waverly Heights, and conceal the Potsdam sandstone below them.

Plymouth township in Montgomery county.

Clay.

Through the central portion of the southern part of the township, a deposit of clay extends from the Schuylkill river. The northern limit of this deposit is Plymouth creek. Its southern boundary is not well defined. In many cases it is associated with clay deposits originating from the decomposition of slates associated with the limestone. Brown hematite ore is found in both the deposits. The age of the clay is questionable. It appears to be deposited in depressions, or against concealed escarpments of limestone.

The clays resultant from the decomposition of the slates are parallel to the limestone beds, a fact which is not demonstrated in the cases of the more recent deposits.

The apparently newer clays are probably a wash from the decomposed slates of both the Potsdam and Trenton or Hudson River groups.

Mesozoic.

About one half of the township is covered by the New Red sandstone. The southern boundary of this formation is very irregular. It crosses the township in a diagonal direction from the southeast to the northwest corner.

From the south township line, northeast of Cold Point, the boundary curves north to a point on the road leading from Cold Point to Sandy Hill, about half way between the former place and the east township line. From this point it curves southward to Hickorytown, beyond which point, a small branch of Plymouth Creek marks its limit for a short distance. From the creek westward its boundary is not sharply defined by escarpments. It extends to the vicinity of the Schuylkill River northwest of Ridge station and follows the general course of the river to Mogeetown. In the vicinity of Hickorytown the boundary is sharply defined, and the sandstone and conglomerate is exposed along the escarpments.

The exposures of the rock are frequent throughout the township.

The formation is composed of shale sandstone and conglomerate. The sandstone and conglomerate usually contains considerable quantities of feldspar. Much of the sandstone is of a light gray color.

Undoubtedly a greater portion of the fine quartz granules of this sandstone have been derived from the disintegration of the Potsdam sandstone.

Limestone (No. II).

The limestone extends over the southern portion of the township and along the Schuylkill river to Mogeetown. It extends along the southern township line from the Schuylkill river to the vicinity of Cold Point. It is flanked on the north by the Potsdam sandstone from Cold Point to a point southwest of Hickorytown, and by the New Red sandstone along the western half of the area.

There are numerous exposures of the rock along the Schuylkill river, also along Plymouth creek and Plymouth railroad.

In the vicinity of Mogeetown the rock pitches at an angle varying from forty to forty-five (45°); descending the river the pitch increases to about 60° near Conshohocken.

A small limestone area occurs north of Cold Point enclosed between two arms of Potsdam sandstone.

A synclinal fold crosses the Schuylkill at Pott's Landing. This fold probably incloses the slates of No. III in the vicinity of Harmansville.

Potsdam Sandstone (No. I).

The Potsdam is found in three belts within the township. The main belt extends from the southeast township line east of Cold Point to a tributary of Plymouth creek west of Hickorytown. This ridge is flanked on the south by the limestones; on the north by limestone and Mesozoic sandstone. The ridge is prominent at Hickorytown.

Along its south base brown hematite iron ore occurs in clay beds which are formed from the decomposed slates of the upper Potsdam sandstone. A small area of Potsdam sandstone extends from the south township line, near the southeast corner, to the road leading from Cold Spring to Sandy Hill. (See Sec. F′.)

A short distance below Mogeetown, east of the National Oil Works, we find an area of Potsdam extending from the river to the edge of the Mesozoic sandstone. It is bounded on the north and south by two small brooks. The relation of this small area to the adjoining limestone is not clear, but it has been shown in section G as if flanked on the north by a fault. The difficulty may be accounted for by nonconformity.

White Marsh township in Montgomery county.

Clay.

The clay deposits extend across the township, in a diagonal, direction from the south township line, east of Marble Hall, to the north township line southwest of Plymouth.

Brown hematite ore occurs both in the recent clay and in the clays derived from the decomposition of slate in position. These two groups of clay have not been separated on the map. In most cases it is impossible to distinguish to which group a deposit belongs. At present I can only say that some of the clays with hematite rest upon limestone and apparently occupy a depression which, seems at some early period, to have been the course of a stream.

Trap.

The Conshohocken trap dyke crosses the township from Conshohocken to the southeast township line at a point north of Flowertown.

Between Conshohocken and Marble Hall, the dyke can be traced continuously. From Marble Hall however, to the Wissahickon creek the dyke is concealed by clay. There is an extensive exposure on the Wissahickon creek, a short distance above A. Welch's place. North of Flowertown the Wissahickon creek is deflected to the west by its contact with the dyke.

This dyke, evidently located along the line of some disturbance, is undoubtedly the course of a fault or fracture. There is however no positive proof of any lateral movement. The dyke was probably formed after the Mesozoic deposits.

Mesozoic Sandstone.

The Mesozoic sandstone occupies a triangular area in the northern corner of the township, west of Fort Washington.

The southern boundary is marked by Pine run, Sandy run and the Wissahickon creek, from the east township line to the grist-mill south of Fort Washington. From this point it is nearly a straight line to the west township line, north of Cold Point. There are few exposures of the rock between the Wissahickon creek and the west township line. The limit of the sandstone however is defined by the color of the soil, and by the Potsdam ridge which flanks the group on the south. From the Wissahickon creek at the Broad Axe road to the East township line, the creeks above mentioned mark the boundary by a well-defined escarpment.

There are numerous exposures of the rock throughout the areas. The principal ones are on the Broad Axe road, near Dickinson's house, and along the North Pennsylvania railroad, at Fort Washington. The formation consists of sandstone conglomerate and shale. The sandstone and conglomerate is composed of the débris of the older rocks flanking the group, which is the case throughout the adjoining townships.

Mica Schists.

In the extreme southwest corner of the township the schists are found on the south flank of the Syenite (Laurentian) belt. The area is small, and extends from the Schuylkill river to the Ridge road at the township line.

The northern limit of the schists and gneisses is marked by a depression which extends from the Ridge road to the Schuylkill, a short distance above Lafayette station.

There are numerous exposures of the rock along the road leading from Lafayette station to the Ridge road. The character of the rock is variable, some of the beds being sandy and somewhat resembling Potsdam sandstone.

Serpentine.

Along the northern edge of the schists, serpentine occurs. It is seen near the Schuylkill river and extends east to the brook which flows into the Schuylkill river at Lafayette station.

East of this brook its existence is questionable.

Limestone (No. II).

The limestone occupies the central portion of the township. It extends from Conshohocken to Cold Point, along the northwest township line; and from the Wissahickon creek to a point east of Valley Green, along the southeast township line. It also extends along this township line for a short distance south of Sandy run.

The north boundary of the limestone, defined by the Potsdam sandstone, is nearly a straight line from Cold Point to the Lancasterville branch of the Wissahickon creek at the Plymouth railroad crossing. It curves north of the Potsdam and extends to the vicinity of the township line west of Lancasterville. The north boundary is then a straight line through Lancasterville to the vicinity of Valley Green.

North of Valley Green a small area of limestone extends from Sandy run beyond the Wissahickon, and is flanked on the north and south by Potsdam sandstone.

The south boundary of the limestone is not sharply defined. It extends from Conshohocken through Marble Hall, and to the southeast township line in the vicinity of the Wissahickon creek. The alternation of slate and limestone along the south or upper margin of the limestone renders it difficult to draw a limit line.

A narrow belt of limestone extends from Spring Mill to the Schuylkill river, through the southern edge of Conshohocken. This belt is flanked on the north by slates and alternations of slate and limestone. Its southern boundary is obscured by the alluvial deposits.

It apparently rests upon the Syenite group. There are numerous exposures of the rock at Spring Mill and in Conshohocken.

Marble is quarried in the vicinity of Marble Hall; and near the northwest township line between Conshohocken and Plymouth. Both of these localities are not far distant from the south margin of the limestone, and probably belong to the same general horizon.

It is impossible to say positively what is the geological structure of the area lying between Cold Point, Flowertown, Marble Hall and Conshohocken.

The belt between Lancasterville and Valley Green, and the belt between Sandy run and the Wissahickon, north of Valley Green, are clearly synclinal basins.

The rock in the neighborhood of the Potsdam sandstone, is a dolomite. The dolomitic character is observable throughout the lower portion of the limestone formation. Marble characterizes the upper portion of the series.

Alternations of slate and limestone occur along the south margin of the limestones from the Schuylkill river at Conshohocken, to the vicinity of Marble Hall. They apparently do not extend south of the trap dyke. Their geological position indentifies them as of Trenton age.

Slates.

A slate belt extends from the southern portion of Conshohocken to the neighborhood of Marble Hall, along the southern side of the trap dyke which bounds the alternations of slate and limestone. Between Spring Mill and Barren Hill these slates seem to rest against the Potsdam sandstone. They are evidently a more recent deposit than the limestone and rest upon it. In many respects they resemble the slates of the South Valley Hill and apparently belong to the same (*Hudson river*) group.

Close to the junction of these slates and the limestone at Spring Mill are located the springs of *Spring Mill*. Their existence has undoubtedly some bearing on the geology. The water seems to drain from the main limestone valley, north of the trap dyke and work its way under the slates which intervene.

Potsdam Sandstone. (*No. I.*)

The Potsdam sandstone forms four belts within the township. Their direction is diagonal to the township lines.

1. The northern belt extends from the east township line, north of Oreland station, to the Wissahickon creek, south of Fort Washington. The eastern end of this belt is the western extension of Camp hill.

Sandy run crosses this belt about the center, bounding the eastern half on the south, the western half on the north.

The Mesozoic sandstone flanks the belt on the north, the limestones flank it on the south.

The outline of the Potsdam along its southern margin is very remarkable. The probability is that there is a nonconformity between the Potsdam and the limestones. Along the line of section E″ however, the succession seems to be regular.

2. The second belt crosses the township from near Oreland station, on the North Pennsylvania railroad, to the northwest township line, west of Lancasterville, near the southwest corner of Whitpain township. Between the north west township line and the Wissahickon creek the Mesozoic flanks the belt on the north. From the Wissahickon to its eastern end and along its south side the limestone extends to a point west of Lancasterville, near the township line; here the sandstone apparently spreads across the synclinal valley, occupied by limestone and connects with the third belt. See Fig. 24.

The structure of the second belt is anticlinal. It forms a prominent ridge nearly its whole length.

Exposures of the rock are numerous. The best exhibitions are above Lancasterville, near the Wissahickon creek and in a quarry north east of Valley Green.

The rock pitches at variable angles from 50° to 60°.

3. The third belt extends from the north west township line north of Cold Point to the Lancasterville branch of Wissahickon southwest of Valley Green. It forms a prominent ridge and is parallel to the belt north of Lancasterville. It is flanked on both sides by limestone with the exception of a narrow belt, near the township line, which connects it with the belt on the north.

The ridge is quite prominent throughout its entire length. It is flanked on the north by clay deposits, which contain brown hematite ore undoubtedly derived from decomposed slates between the Potsdam and the limestone, geologically at the top of the Potsdam.

4. The fourth belt crosses the southern portion of the township and extends from Spring Mill to the southeast township line, a short distance west of the Wissahickon, passing through Barren Hill P. O.

At Spring Mill the belt ends abruptly and does not exist west of this point. The probability is that nonconformity between it and the underlying Syenite has been the cause of its termination here.

The extent of the formation, between Barren Hill and Spring Mill, is not sharply defined. Between Barren Hill and the township line however the belt forms a prominent ridge.

There are outcrops of the sandstone at Spring Mill and also along the ridge in the vicinity of Barren Hill and near the township line. It is a white sandstone and thinly bedded quartzite.

The rocks of the first, second and third Potsdam belts through the township, are generally discolored, varying from dark red to gray color. Where they have been subjected to weathering they are usually light gray.

East of Cold Point micaceous iron ore (specular ore) has been observed in the sandstone. The quantity is usually very small.

Syenite group. (Laurentian.)

The Syenites cross the south corner of the township, south of the Potsdam sandstones and north of the mica schists. They cross the southeast township line east of the Ridge road. Along the Schuylkill river they extend from Spring Mill to the first brook above Lafayette station.

There are numerous exposures along the roads which cross the belt. The escarpment along the Schuylkill river affords the finest exposures. The anticlinal structure and unconformability of the schists, flanking this group on the south, is demonstrated along this escarpment. See Fig. 12.

Springfield township in Montgomery county.

Clay.

A belt of clay crosses the township in a diagonal direction between Chestnut Hill and Flowertown, extending to the vicinity of Edge Hill furnace. What portion of this deposit may belong to the decomposed slates of the Potsdam sandstone, I am unable to state. Some of the clays probably belong to the limestone series. Iron ore is extensively mined in this township.

Trap.

Trap enters the township north of Flowertown. It has also been found north of Sandy run, along the township line.

Mica schists and gneisses.

The micaceous rocks occupy that portion of the township lying south of a line drawn through the Chestnut Hill toll-house and the northwest corner of Cheltenham township.

The branch of the Wissahickon rising in this corner of Cheltenham township marks the north boundary of the schists from the east township line to the vicinity of Chestnut Hill.

The schists also occur in that portion of the township lying west of Ridge road. There are exposures of the rock in the vicinity of Chestnut Hill and also in the vicinity of Lafayette station.

The rock is usually garnetiferous mica schists with occasional slaty layers. Hornblendic gneiss is not as frequently met with in this township as in the adjoining ones.

The north boundary of these rocks is difficult to determine at Chestnut Hill, but an uncomformity is evident. The rock is considerably broken.

Serpentine and soapstone.

Serpentine and steatite occur south of Lafayette station on the Schuylkill river. Soapstone is quarried extensively at this point. The quarry is owned by S. Prince and known as Prince's quarry. The steatite is regularly interstratified with the schists and can be traced some distance east of the quarry.

Limestone (No II.)

Limestone extends across the central portion of the township, from the southeast corner to the Wissahickon creek and along the northwest township line to a point north of Flowertown. North of Oreland station and south of Sandy run, a narrow belt crosses the north corner of the township. The boundary of the limestone is the Potsdam sandstone and its decomposed slaty beds.

The structure is evidently synclinal; but probably complicated by folding, and possibly faulted, in the region of Flowertown. (See Section E.)

There are numerous limestone quarries throughout the township.

The narrow limestone belt south of Sandy run, is flanked on both sides by Potsdam. Lime is burned extensively along Sandy run.

Potsdam Sandstone.

There are four belts of Potsdam sandstone within this township.

1. The most northern of these is a portion of Camp hill

north of Sandy run. It occupies a triangular space in the extreme north corner of the township. It forms a prominent ridge.

2. The second belt enters the township a short distance southwest of Sandy run and extends to the vicinity of Oreland station. It is the eastern extension of the Lancasterville-Valley Green anticlinal of the adjoining township. It forms a low ridge, disappearing in the direction of Oreland.

3. The third belt extends from the south east township line, south of Edge Hill iron works, to the township line north west of Chestnut Hill. Crossing the corner of Philadelphia it reënters the township, crossing it west of the Wissahickon creek. This belt is the same as the Edge Hill ridge. In the vicinity of the Wissahickon the ridge is quite prominent, elsewhere however it is much eroded and is with difficulty distinguishable.

There are exposures of the rock along the township line roads, and at quarries north of Chestnut Hill and west of the Wissahickon. The rock is white and gray quartzite and white sandstone, with mica. Along the central portion of the belt the sandstone is soft and readily decomposed. This difference in character probably accounts for the absence of a defined ridge.

4. The fourth belt is parallel to the last and extends from the angle in the township line, at the northwest corner of Cheltenham township to the vicinity of Chestnut Hill.

A brook flowing from this corner into the Wissahickon creek marks the course of the belt.

The Syenite group flanks the rock on the south, and it is continuous with the Waverly Heights belt.

The mica schists flank it on the south. Its western limitation seems to be abrupt and may be due to this non-conformity to the Syenite group.

Syenite group. (Laurentian.)

A narrow belt extends from the southeast township line to the Philadelphia county line, northwest of Chestnut Hill. It is flanked on the north by the Potsdam sandstone, on the south by the Potsdam and mica schists. There are few exposures of the rock along the roads and several quarries near the Toll House north of Chestnut Hill. This belt is the same as that in the western portion of the township, southwest of the Wissahickon creek, which extends from the vicinity of the Ridge road to the Potsdam belt of Barren Hill and Spring Mill. Its junction with the schists is not clearly defined.

Upper Merion township.

Clay.

Clay covers a large portion of the limestone valley, especially in the southeastern portion of the township. The principal deposits are along the southern edge of the limestones.

Iron ore occurs in large quantities in this deposit, and is extensively mined. The deposits extend from the Schuylkill river beyond Henderson station.

Some of these clays are no doubt the result of a decomposition of slates in position; but there are others which apparently lie upon the limestones and occupy depressions which were formed in the limestones anterior to the deposit of the clay.

Mesozoic.

The New Red sandstone extends along the Schuylkill river from Valley Forge to Bridgeport.

Its southern limit is very irregular.

From the center of Bridgeport it extends westward to Elliott's run, north of the King of Prussia P. O.

From this point it curves northwestward to Port Kennedy.

From Port Kennedy to Valley Forge it forms a narrow belt with an irregular south boundary.

West of Elliott's Run and northwest of King of Prussia P. O., we find an island of the Mesozoic sandstone, cut off from the main area by erosion, exposing the underlying limestone. This island extends a short distance over the township line into Chester county.

South of the forks of Elliott's run a small area of sandstone also occurs.

At Henderson station on the Chester Valley railroad is an extensive deposit of sandstone and conglomerate. It has somewhat the appearance of the Mesozoic, but I am inclined to consider it belonging to a more recent deposit. It may have been deposited by the Schuylkill river, or some stream flowing in a diagonal direction from Port Kennedy to the neighborhood of Conshohocken.

There are numerous exposures of the sandstone and shale along the Schuylkill river and elsewhere.

Trap.

A trap dyke crosses the southern edge of the township, from West Conshohocken through Mechanicsville to the west township line a short distance above Gulf creek. It forms a bold abutment at West Conshohocken on the west side of the river, and can be traced, uninterrupted, across the township. It occurs in the mica slates of the South Valley Hill (Hudson river slates.)

South Valley Hill slates. (Hudson river.)

These slates extend across the southern portion of the township from the Schuylkill river to the Chester county line. Between West Conshohocken and the Gulf road, they extend south of the township line. Between the Gulf road and the township line Gulf creek marks their boundary. The north boundary, between the Schuylkill and Gulf Mills, is defined by Gulf creek. A short distance west of Gulf Mills the slates curve northward and an arm or finger extends eastward to a point northeast of Gulf Mill; from which point the north boundary is nearly a straight line to the west township line, south of the Chester Valley railroad.

The slates form a prominent ridge throughout the entire length of the belt. They rise abruptly from Gulf creek and are defined on the south by an escarpment along their southern margin.

The slates are exposed in numbers of places. The best exposures of the rock are above West Conshohocken, along the Schuylkill river; and between Gulf Mills and the south township line, along Gulf creek. The rock is mica schist and chloritic mica schist, with beds of milky quartz. The quartz is usually in lenticular bodies. Occasional beds of sandstone and quartzite are met with.

The structure of this belt is anticlinal and synclinal.

A synclinal basin extends from Chester county to a point northeast of Gulf Mill; a second synclinal extends through the southern portion of the belt in the vicinity of the Trap dyke.

Between these synclinal folds we find an anticlinal escarpment extending through Gulf Mills and along the course of Gulf creek to the Schuylkill river.

Alternations of Slate and Limestones. (Trenton.)

Flanking the slates of the South Valley Hill on the north, runs a narrow belt of alternating slates and limestones, conformable with the slates above and with the limestones below.

It is difficult to draw a line of demarkation between the groups, inasmuch as the limestone predominates towards the base and diminishes towards the top.

The alternations may be seen in the vicinity of Gulf Mills, where they are folded upon themselves, conforming to the contortions of the overlying slates, and consequently the underlying measures.

This group may be seen along the entire northern flank of the South Valley Hill and are exposed in nearly all the brooks which cross the belt.

Limestone (No. II).

The limestones occupy the central portion of the township extending from the Schuylkill river, below Bridgeport, to the Chester county line. Their southern margin is defined by the alternations of slate and limestones which flank the South Valley Hill on the north.

The limestone extends along the Schuylkill river from a point about half way between West Conshohocken and Matsunk, to Swedesburg, or the northern edge of Bridgeport.

Between the river and the southwest corner of Bridgeport the Potsdam sandstone flanks the limestone on the north.

Between Bridgeport and Hudson station, an arm of limestone extends northwest, to a little beyond the Chester Valley turnpike and is overlaid by the New Red sandstone. This limestone area is flanked on the south by the Potsdam sandstone to the vicinity of Hudson station. From this point northwest to the vicinity of Elliott's run it flanks the Potsdam sandstone on the south.

From Elliott's run to Port Kennedy it can be traced along an escarpment, north of King of Prussia P. O., to the head of Trout run, where it widens out, extending over a large area.

Southwest of Port Kennedy the limestone is flanked on the north by the Mesozoic and spreads into a bay flanked by Potsdam sandstone. The south margin extends from the Schuylkill river, opposite the upper end of Conshohocken, to the west township line, a short distance south of the Chester Valley railroad.

Limestone is quarried extensively in the vicinity of Port Kennedy, west of Bridgeport, and at many other localities.

The Marble beds are located near the southern margin of the limestone area and near the slate and limestone alternations. They are consequently near the top of the limestone group. The belt extends across the township.

The principal marble quarries are Conrad's quarry, near the Schuylkill below Matsunk, Hitner's and Henderson Marble Co.'s quarries south of Henderson station, and Adams' and Derr's quarry south of King of Prussia P. O.

Potsdam Sandstone.

There are three areas of Potsdam sandstone within the township. One of these is located in the southern part of the town of Bridgeport. It forms a prominent ridge extending from the Schuylkill river to the southwest corner of the town. It is flanked on the north by the New Red sandstone and on the south by limestones. The escarpment on the south is very abrupt.

A narrow belt of Potsdam sandstone is found west of Bridgeport. It extends from the vicinity of Henderson station to the Mesozoic sandstone, east of Elliott's run. South east of the Chester Valley turnpike the ridge formed by this rock is quite prominent. Limestone flanks this area on both sides, and it is evident from its position that it is an anticlinal.

In the northwest corner of the township we find the Potsdam forming a prominent ridge south and east of Valley Forge.

The rocks extend from Valley Forge south beyond the county line, along the course of Valley creek. Its north boundary is a short distance south of the river, the Mesozoic flanks it on the north. It extends to a point about half way between Valley Forge and Port Kennedy. South of this point a U shape depression or bay is formed by the limestones, which extends to the vicinity of the school-house between Fort Hamilton and Fort Washington. The north arm, flanking the limestones on the south, is not sharply defined within the township.

The structure of this area seems to be simple folds, anticlinal and synclinal. Along the course of Valley creek, from Valley Forge to the township line, there are numerous exposures of the rock. It is generally a slaty micaceous sandstone, with quartzite, usually dark colored. In the southern part of Bridgeport there are several exposures of the rock. It is usually dark grey or red and in some places resembles somewhat in color, the sandstone of the Mesozoic.

Lower Merion Township in Montgomery county.

Mica Schists and Gneises.

The mica schists extend over the southern portion of the township. Their northern limit is a line between Young's Ford road on the Schuylkill river, to the west township line a short distance above Bryn Mawr. The boundary is usually defined by an escarpment. They flank the Syenite group on the south and are softer and more rapidly decomposed than the rocks of that group.

The schists are extensively exposed along the Schuylkill river from Young's Ford road to the south township line.

Along the northern edge are indications of a definite synclinal fold. South of this fold the rock seems to have a northwest undulating dip. The southern edge of this fold is somewhere in the vicinity of the *serpentine* belt passing south of Lafayette, a short distance north of Merion Square and south of Bryn Mawr. The rocks north of this belt are usually slaty micaceous gneiss, with some hornblende and granite. South of this line the garnetiferous schists pass gradually into mica schists and gneisses. South of Merion Square micaceous flagstone is quarried.

Serpentine.

Along the northern edge of the gneissic group, a belt of serpentine is exposed in various places between the Schuylkill river and the west township line. There is some doubt as to whether it be continuous, but it is undoubtedly one and the same horizon.

There is a quarry near the Schuylkill river; also an abandoned quarry north of Merion Square. It has been observed on the Gulf road north of Bryn Mawr.

A second belt is found opposite the Lafayette soapstone quarries. It has been traced to a point on the Pennsylvania railroad, south of Bryn Mawr. It is exposed in numerous places along its course. Near the Schuylkill river soapstone is quarried extensively. West of Merion Square along Black Rock road there is an extensive exposure of magnesian rocks belonging to this belt. In the railroad cut south of Bryn Mawr the decomposed rock is visible.

These two belts of magnesian rocks I consider to belong to the same or approximately the same horizon, repeatedby a fold, as indicated by the structure of the included measures.

South of Gulf Mills along the junction of the slates of the South Valley Hill with the Syenite (Laurentian) group, a small area of serpentine has been found. This undoubtedly belongs to a belt of serpentines which flank the South Valley Hill slate group on the south, and is found extending across Radnor township, Delaware county, and through part of Chester county. It seems to occupy a similar position to the belt which flanks the Syenite group on the south in Lower Merion township.

South Valley (Hudson River) slates.

The slates of the South Valley Hill enter the northern edge of the township between West Conshohocken and the Gulf Mill road. They are exposed in a few places, but generally much decomposed.

They rest against the Syenites, and near West Conshohocken lie upon the limestone (No. II.)

Iron ore has been mined along the edge of this group. It is probably derived from the decomposition of the slates.

Limestone (No. II).

Limestone is found in the northeast corner of the township. The area is small and extends from the south edge of West Conshohockon westward a short distance along the line of a small brook.

It occupies a position between the Syenite group on the south and the slates on the north. It rests upon the Syenites and is overlaid by the slates. (See section G′.)

Near the river it is dolomitic and resembles the limestone of the southern part of Conshohockon, on the opposite side of the river. Towards its western limit the limestone is impure, and alternating with sandy and hornblendic layers. Probably these impurities were derived from the disintegration of the Syenite.

Syenite group (Laurentian).

This belt extends from the Schuylkill river to the west township line. The southern limit is a line drawn from Young's Ford road on the Schuylkill river, to a point on the west township line between Bryn Mawr and Rosemont station. The north boundary is a short distance south of the north township line, between the Schuylkill river at

West Conshohocken, and the Gulf road, west of which point it extends to the neighborhood of Gulf creek.

The north side of this belt is very abrupt and its limit is defined by an escarpment, along which the Schuylkill flows, between West Conshohockon and Spring Mill station. The deflection in the course of the Schuylkill at this point is caused by the resistance offered by the hard Syenitic rocks, which are here flanked by limestones on the north. The escarpments along the southern edge of the belt are well defined.

Along the Schuylkill river there are numerous exposures of the rock, as well as along the roads crossing the area.

Along the Schuylkill there is evidence of an anticlinal fold which is faulted or cut off its south side. (See section G.) The unconformity of the overlying schists is well exhibited.

Philadelphia county.

Philadelphia county extends from the Poquessing creek on the east, to Cobb's creek on the west. Its southern boundary is formed by the Delaware river. The north boundary is a zig zag line, formed by the south boundary of Montgomery county.

Along the northern edge of the county we find the Potsdam sandstone in two places and the Syenite group north of Chestnut Hill.

Otherwise the mica schists and gneisses occupy the entire county, unless limestone be proven to exist north of Somerton and flanking the Potsdam sandstone on the south. Its existence is exceedingly doubtful.

The entire gneissic and micaceous series seems to belong to one geological formation. Thus far sharply defined subdivisions have not been established. Sub-divisions have been assumed and indicated onthe accompaning map. These belts of rock fade into each other, and the colors on the map are intended to convey the idea here advanced.

The pitch of the rock is generally north-westward except along the northern edge, where we find invariably a reverse dip, which, with the repetition of the rocks along this edge is proof of their geological position, as described in the Introduction.

Alluvium.

The entire northern portion of Philadelphia county, is covered by gravel.

Along the Delaware river we find, in a number of places, *mud* deposits which are the most recent. These deposits cover a greater portion of the south end of the city of Philadelphia.

Flanking these a belt of *gravel* extends along the course of the river, over the low land which is designated as Trenton gravel. This was deposited by the river before it had receded to its present channel.

These gravels merge into what are termed the Philadelphia *brick clays*, red gravel and yellow gravel, which extends over the southern portion of the county. It is very variable in thickness. Throughout the southern portion of Philadelphia it is not far from a hundred feet in depth. There are exposures of this gravel in all sections of the city where streets have been graded down.

A large portion of the gravel has been derived from the débris of the Palæozoic rocks along the course of the upper Delaware, into Lower Merion township, Montgomery county.

Chestnut Hill Garnetiferous Group.

This belt is exposed across the northern end of the county, between Chestnut Hill and the Schuylkill river. Its northern limit is a diagonal line across the northern corner of the county. A short distance west of the Wissahickon creek, it extends north of the county line.

Its southern boundary is not sharply defined. It is indicated as extending from the southern edge of Chestnut Hill to the Schuylkill river, about half way between Lafayette station and Manayunk.

The rocks of this belt are garnetiferous mica schists, thin bedded sandy gneisses, and hornblendic slate.

The main distinguishing feature is the serpentine and steatite deposits. These extend across the north corner of Philadelphia county.

Serpentine and Steatite.

Serpentine is found in the northwestern edge of Chestnut Hill, and extends across the Wissahickon creek to a point about half way between the Wissahickon and Ridge road. It is also found a short distance above Manatawna and at a point about half way between Manatawna and Lafayette.

By consulting the accompanying map it will be seen that these patches or strips of serpentine are on a line drawn from Chestnut Hill to the steatite quarry, below Lafayette station on the Schuylkill. They clearly belong to one and and the same horizon.

The rock is well exposed along the road leading from the Wissahickon to Chestnut Hill.

Manayunk Mica Schists and Gneisses.

This belt is exposed along the Schuylkill river from the vicinity of the Falls of the Schuylkill to a point about half way between Manayunk and Lafayette station. Its north boundary is south of Chestnut Hill. The south line is in the vicinity of Germantown.

Along the Schuylkill river the rocks are exposed to the best advantage. We find them gradually passing from a garnetiferous mica schist on the north, to a micaceous feldspathic gneiss on the south side of the belt. The transition is a gradual one.

Between the Falls of the Schuylkill and Manayunk some hornblendic slates are found. Along the Wissahickon creek there are extensive exposures.

There seems to be a *chloritic* character throughout portions of the belt.

A short distance below the mouth of Cresheim creek, a small bed of steatite or serpentine occurs. This seems to be local, as it has not been observed elsewhere.

Philadelphia Mica Schist and Gneiss group.

This belt extends from the Poquessing creek to Cobb's creek, and from the Delaware river on the south to the vicinity of the Falls of the Schuylkill along the Schuylkill river. Through the eastern portion of the county it extends north beyond the county line. The rock is exposed along the Poquessing, Pennepack, and Tacony creeks from the Delaware river to the county line. The finest exposures are found along the Schuylkill river. They are exposed for some distance below Gray's Ferry bridge.

We find the gneisses and schists merging into each other throughout this belt, in a similar manner to the two belts north of it.

Hornblendic beds are found in a number of places. The largest of these are along the Schuylkill river above Columbia bridge and on the river bank, below Strawberry Mansion, at the south end of the river road. Above this upper hornblendic belt, the rock is a feldspathic micaceous gneiss, alternating with mica schists above the Falls of the Schuylkill.

The rocks above Columbia bridge are slaty micaceous schists and gneisses.

Between Columbia Bridge and the vicinity of Gray's Ferry bridge are alternating micaceous gneisses, mica schists, and thin beds of hornblendic gneiss or slate. Lenticular beds of quartz occur throughout the mass.

In the vicinity of Gray's Ferry the rock is very feldspathic and forms beds of *kaoline*. Some of these deposits are quite free from foreign matter and nearly white. South of Gray's Ferry the micaceous gneiss is exposed along the river.

At Frankford compact gray gneiss is quarried.

At the western end of Market street, the central east and west street of the city, on the east bank of Cobb's creek, is a quarry of quartzose hornblendic gneiss resembling that found at Columbia bridge on the Schuylkill river.

It is difficult to trace any particular horizon from point to point, on account of the contortions and dislocations met with throughout the belt.

Analyses of minerals and rocks from Bucks, Montgomery and Philadelphia counties, Pa.

No. 217, at Station 2826A, one and one half miles east from Center Valley. (Collection of Prof. Prime.)

Granite. Composed of greyish-white feldspar in cleavage masses, from 2–15^{mm} in diameter, mixed with a darker grey quartz in angular fragments; contains also a few patches of greenish-greyish white dull feldspar, from 2–10^{mm} in diameter, and traces of muscovite and magnetite.

The *cleavable feldspar* has been analyzed by F. A. Genth, Jr., who found:

Loss by ignition,	= 0.58%
Silicic acid,	=66.72
Alumina,	=18.67
Ferric oxide,	=trace.
Magnesia,	= 0.23
Lime,	= 0.84
Lithia,	=faint trace.
Soda,	= 2.56
Potash,	= 9.80
	99.40

No. 5063. Report OO. *Dolerite* from an exposure on the hillside at the extreme south end of New Hope.

Compact dark-grey cryptocrystalline rock, with a few very small patches of yellowish-white crystalline mineral. My analysis gave:

Loss by ignition,	= 1.58%
Silicic acid,	= 50.70
Titanic acid,	= 0.68
Phosphoric acid,	= 0.30
Alumina,	= 19.86
Chromic oxide,	=trace.
Ferric oxide,	= 7.34
Ferrous oxide,	= 1.79
Manganous oxide,	=trace.
Magnesia,	= 5.86
Lime,	= 1.94
Lithia,	=trace.
Soda,	= 3.55
Potash,	= 6.95
	100.55

No. 5064. Report OO. *Dolerite* from 250 yards south of where No. 5063 was taken, at New Hope.

Compact grey cryptocrystalline rock. Implanted in it are small patches from about 1–5^{mm} in diameter, which appear to be largely quartz with a greyish-brown vitreous mineral inclosed.

The analysis, which I have made of the whole rock, gave:

Water with some carbonic acid,	= 2.25%
Silicic acid,	= 51.35
Titanic acid,	= 1.00
Phosphoric acid,	= 0.20
Alumina,	= 20.42
Ferric oxide,	= 5.91
Ferrous oxide,	= 2.20
Manganous oxide,	=trace.
Magnesia,	= 4.91
Lime,	= 2.62
Lithia,	=trace.
Soda,	= 3.92
Potash,	= 5.24
	100.02

Mineral, implanted in this dolerite.

It was picked out as carefully as possible, in the hope that its exact character could be ascertained, but although free from the inclosing rock, it was impossible to separate it with accuracy from the associated quartz. After deducting 14.7 per cent., which were not soluble in chlorhydric acid, the composition of the soluble part was:

Water,	= 5.19%
Silicic acid,	= 40.41
Alumina,	= 22.61
Ferric oxide,	= 7.41
Magnesia,	= 2.11
Lime,	= 21.42
Soda,	= 1.24
Potash,	= 0.61
	101.00

No. 5066. Report OO. *Dolerite*, opposite Goat Hill, 100 yards south of where No. 5064 was obtained.

The texture is so coarse that the feldspathic and pyroxenic constituents can be distinguished without the aid of a lens. Color whitish, with dark grains. My analysis gave:

Loss by ignition,	= 0.41%
Silicic acid,	= 53.92
Titanic acid,	= 0.43
Phosphoric acid,	= 0.19
Alumina,	= 18.72
Ferric oxide,	= 4.89
Ferrous oxide,	= 4.37
Manganous oxide,	= trace.
Magnesia,	= 3.86
Lime,	= 10.42
Soda,	= 3.08
Potash,	= 0.81
	101.10

No. 5067. Report OO. *Dolerite.* Surface bowlder on Bowman's Hill, two miles south of Goat Hill, between New Hope and Brownsburg.

Texture crystalline; some of the constituents, especially the feldspathic portion, quite conspicuous. Appears to contain a considerable amount of quartz, and traces of pyrite and chalcopyrite. Color brownish. My analysis gave:

Loss by ignition,	= 1.26%
Silicic acid,	= 60.25
Titanic acid,	= 1.85
Phosphoric acid,	= 0.19
Alumina,	= 12.35
Ferric oxide,	= 3.36
Ferrous oxide,	= 9.58
Manganous oxide,	= trace.
Magnesia,	= 1.20
Lime,	= 4.43
Soda,	= 2.76
Potash,	= 2.75
	99.98

No. 5069. Report OO. *Dolerite* from near Brownsburg, four miles from New Hope, from a surface bowlder on Jericho Hill.

Finely crystalline rock; only a few of the feldspathic particles can be distinguished by the aid of a lens. Brownish-grey. My analysis gave:

Loss by ignition,	= 0.93%
Silicic acid,	= 52.82
Titanic acid,	= 0.26
Phosphoric acid,	= 0.19
Alumina,	= 16.18

Ferric oxide,	= 5.45
Ferrous oxide,	= 5.72
Magnesia,	= 5.88
Lime,	= 8.38
Soda,	= 2.56
Potash,	= 0.82
	99.19

No. 5072. Report OO. *Dolerite*, from opposite Mount Pleasant, two miles from Lumberville.

Similar to No. 5069, but of finer grain. My analysis gave:

Loss by ignition,	= 0.29%
Silicic acid,	= 52.91
Titanic acid,	= 1.03
Phosphoric acid,	= 0.12
Alumina,	= 14.45
Ferric oxide,	= 6.42
Ferrous oxide,	= 4.38
Magnesia,	= 8.34
Lime,	= 9.92
Soda,	= 1.80
Potash,	= 0.57
	100.23

No. 5081. Report OO. *Dolerite* from between Quakertown and the north end of the North Pennsylvania railroad tunnel.

Finely crystalline; the constituents can be distinguished by a good lens. Brownish. My analysis gave:

Loss by ignition,	= 0.49%
Silicic acid,	= 53.16
Titanic acid,	= 0.86
Phosphoric acid,	= 0.15
Alumina,	= 13.90
Ferric oxide,	= 4.40
Ferrous oxide,	= 5.10
Magnesia,	= 10.63
Lime,	= 9.75
Soda,	= 1.16
Potash,	= 0.48
	100.08

No. 5082. Report OO. *Dolerite* from between Quakertown and the north end of the North Pennsylvania railroad tunnel, one mile from the north end of the tunnel.

Compact, dark grey crypto-crystalline rock, with minute cavities lined with a white zeolitic mineral and a trace of carbonate of lime. My analysis gave:

Ignition, (water and little carbonic acid,)	= 3.53%
Silicic acid,	= 51.93
Titanic acid,	= 0.87
Phosphoric acid,	= 0.20
Alumina,	= 22.48
Ferric oxide,	= 8.65
Ferrous oxide,	= 1.54
Magnesia,	= 3.59
Lime,	= 0.89
Lithia,	=trace.
Soda,	= 1.48
Potash,	= 5.46
	100.62

No. 5084. Report OO. *Dolerite*, from a surface bowlder on the northeast flank of Haycock Hill. Compact brownish grey cryptocrystalline rock. My analysis gave:

Loss by ignition,	= 0.34%
Silicic acid,	= 52.54
Titanic acid,	= 0.63
Phosphoric acid,	= 0.23
Alumina,	= 14.79
Ferric oxide,	= 4.38
Ferrous oxide,	= 6.34
Magnesia,	= 7.95
Lime,	= 11.21
Soda,	= 2.00
Potash,	= 0.67
	101.08

No. 5086. Report OO. *Dolerite*, from the summit of Haycock Hill.

Resembles closely No. 5031, and contains according to my analysis:

Loss by ignition,	= 0.48%
Silicic acid,	=52.73
Titanic acid,	= 1.02
Phosphoric acid,	= 0.16
Alumina,	=11.77
Ferric oxide,	= 3 50
Ferrous oxide,	= 6.45
Magnesia,	= 9.33
Lime,	=10.96

Lithia,	=faint trace.
Soda,	= 1.53
Potash,	= 0.48
	98.41

Section A.

No. 4310. Report OO. *Syenitic Gneiss*, from first exposure on Delaware river, below J. Demmer's house, two miles above Pa. R.R. bridge at Morrisville.

Composed of a fine-grained mixture of plagioclase, greenish-black hornblende, a little magnetite and quartz which is more or less opalescent.

An analysis made by F. A. Genth, Jr., gave the following:

Loss by ignition,	= 0.83%
Silicic acid,	=57.51
Titanic acid,	= 2.01
Phosphoric acid,	= 0.33
Alumina,	=14.45
Ferric oxide,	= 5.54
Ferrous oxide,	= 6.49
Manganous oxide,	= 0.57
Magnesia,	= 4.47
Lime,	= 4.20
Soda,	= 3.22
Potash,	= 0.21
	99.83

Nos. 4351–4360. Report OO. *Granitic Rocks*, from Moon's quarry, composed mostly of white feldspar and opalescent quartz with small patches of a fine scaly dark greenish or brownish mineral, probably resulting from the alteration of staurolite. Most of the feldspar appears to be orthoclase, but there is some which is very indistinctly striated and belongs to *Oligoclase*. I have analyzed the latter and found:

Loss by ignition,	= 0.44%
Silicic acid,	= 63.44
Alumina,	= 21.11
Ferric oxide,	= 0.47
Magnesia,	= 0.26
Lime,	= 3.32
Soda,	= 6.29
Potash,	= 4.42
	100.75

Nos. 4362–4371. Report OO. *Garnet Rock*, from Moon's quarry. Bands of granular greyish-red garnet from 45–50^{mm} in thickness, between thin layers of plagioclase and quartz and a few scales of biotite.

I have analyzed the *garnet* from this garnet rock and found :

Loss by ignition,	= 0.70
Silicic acid,	= 40.35
Alumina,	= 23.41
Ferric oxide,	= 2.60
Ferrous oxide,	= 20.53
Manganous oxide,	= 0.34
Magnesia,	= 11.13
Lime,	= 1.32
	100.38

No. 4378. Report OO. *Gneiss* on Hiram Burges' estate, on Delaware river, opposite the road to Fallsington.

Finely granular mixture of white plagioclase, grey quartz and fine scales of brown biotite. An analysis, made by F. A. Genth, Jr., gave :

Loss by ignition,	= 1.21%
Silicic acid,	= 66.32
Titanic acid,	= 2.11
Phosphoric acid,	= 0.32
Alumina,	= 12.60
Ferric oxide,	= 2.22
Ferrous oxide,	= 1.44
Manganous oxide,	=trace.
Magnesia,	= 4.13
Lime,	= 5.25
Soda,	= 3.06
Potash,	= 1.76
	100.42

No. 4387 and 4388. Report OO. *Diorite* from the west side of the Pennsylvania canal on S. Dana's place near Morrisville.

Albite and hornblende are the principal constituents, accessory are, fine scales of brown biotite and minute quantities of quartz. The albite forms the matrix through which crystalline particles (the largest from 3 to 6^{mm} in size) of greenish hornblende, together with the biotite are disseminated. In the coarser mixtures quartz is rare, in the finer and more uniformly mixed minerals it is present in larger quantities. The albite is in some places separated in larger, purer masses of a white color, and, in cavities, in small crystals; the cleavage planes show broad striation. In some parts of the rock the albite has changed into prochlorite. There is also present, in small quantity, a columnar yellowish green mineral, probably titanite.

I have analyzed the whole rock, consisting of the more evenly mixed components (without chlorite,) which contains:

Loss by ignition,	= 0.86%
Silicic acid,	= 50.62
Titanic acid,	= 1.34
Phosphoric acid,	= 0.20
Alumina,	= 15.76
Ferric oxide,	= 2.13
Ferrous oxide,	= 7.49
Manganous oxide,	= 0.14
Magnesia,	= 7.61
Lime,	= 9.42
Soda,	= 3.79
Potash,	= 0.96
	100.32

Albite. Crystalline cleavage masses, gave me as follows:

Spec. Grav.,	=2.690
Loss by ignition,	= 0.53%
Silicic acid,	= 67.01
Alumina,	= 19.44
Ferric oxide,	= 0.52
Magnesia,	= 0.24
Lime,	= 1.71
Soda,	= 10.48
Potash,	= 0.30
	100.23

Prochlorite, in dark green scales, resulting from the alteration of albite, gave me the following composition:

Loss by ignition,	= 11.58%
Silicic acid,	= 25.98
Alumina,	= 21.08
Ferric oxide,	= 3.72
Ferrous oxide,	= 19.96
Manganous oxide,	=trace.
Magnesia,	= 18.29
	100.61

The *Hornblende*, of a dark grayish-green color, selected from the diorite, was analyzed by me and gave:

Loss by ignition,	= 1.22%
Silicic acid,	=46.25
Titanic acid,	= 1.50
Alumina,	=12.32
Ferric oxide,	= 3.65
Ferrous oxide,	=10.71
Magnesia,	=10.37
Lime,	=11.02
Soda,	= 1.44
Potash,	= 1.02
	99.50

No. 4409. Report OO. *Syenitic gneiss* from City Bridge, Morrisville, on Delaware river.

It is fine grained and consists principally of greenish-black hornblende, plagioclase, quartz and a little biotite. The analysis made by F. A. Genth, Jr., gave the following results:

Spec. Grav.,	=3.035
Loss by ignition,	= 1.10%
Silicic acid,	= 49.41
Titanic acid,	= 1.00
Phosphoric acid,	= 0.25
Alumina,	= 16.33
Ferric oxide,	= 5 20
Ferrous oxide,	= 7.03
Manganous oxide,	= 1.31
Magnesia,	= 4.98
Lime,	= 9.15
Soda,	= 4.11
Potash,	= 0.80
	100.67

No. 4445. Report OO. *Gneiss* from south of City Bridge, Morrisville. Consists of bands of greyish-white quartz with white feldspar, part of which is striated. These are separated by seams of brownish-black biotite in fine scales. In some places the biotite changes into a chloritic mineral. I have analysed the purest scales of *biotite* which contained as follows:

Loss by ignition,	= 1.21%
Fluorine,	= 0.79
Silicic acid,	= 35.81

Titanic acid,	= 4.21
Alumina,	= 17.14
Ferric oxide,	= 2.73
Ferrous oxide,	= 18.49
Manganous oxide,	= 0.33
Magnesia,	= 9.79
Soda,	= 0.30
Potash,	= 9.46
	100.26
Less oxygen, equivalent to fluorine,	= 0.33
	99.93

No. 4446. Report OO. *Granitic rock* from the same locality is largely composed of small masses of greyish white cleavable feldspar (orthoclase) with smaller grains of quartz and patches of a fine scaly, chloritic mineral, similar to that from Moon's quarry, which probably results from the decomposition of staurolite. My analyses of the *feldspar* gave:

Loss by ignition,	= 0.28%
Silicic acid,	= 66.02
Alumina,	= 18.81
Ferric oxide,	= 0.19
Magnesia,	= 0.11
Lime,	= 0.64
Soda,	= 2.78
Potash,	= 11.53
	100.36

No. 4452. Report OO. *Gneiss* from S. of ice-house, S. of City Bridge, Morrisville.

It has been analyzed by F. A. Genth, Jr., who found:

Spec. gravity,	=2.584
Loss by ignition,	= 0.60%
Silicic acid,	= 66.21
Alumina,	= 19.32
Ferric oxide,	= 0.33
Magnesia,	= trace.
Lime,	= 0.28
Soda,	= 3.19
Potash,	= 9.23
	99.16

Section B.

No. 4457. Report OO. *Pyroxene-Syenite* from Vanartsdalen's quarry.

White plagioclase in which are imbedded large irregular crystals and crystalline masses of dark greenish-grey pyroxene, from 5–25mm. by 2–15mm. in size, a little quartz, a few scales of graphite and a little titanite. The analysis of the plagioclase, which I have made, proves it to be *oligoclase.* It gave the following results:

Loss by ignition,	= 0.23%
Silicic acid,	= 62.58
Alumina,	= 23.27
Ferric oxide,	= 0.23
Magnesia,	= 0.15
Lime,	= 4.88
Soda,	= 8.05
Potash,	= 1.04
	100.43

No. 4458. Report OO. *Pyroxene-Syenite* from Vanartsdalen's quarry.

A similar rock, but of smaller grain than the last. I have analyzed the pyroxene and found:

Loss by ignition,	= 0.55%
Silicic acid,	= 51.97
Alumina,	= 2.53
Ferric oxide,	= 0.82
Ferrous oxide,	= 13.36
Manganous oxide,	= 0.33
Magnesia,	= 8.37
Lime,	= 22.41
	100.34

No. 4459. Report OO. *Pyroxene-Syenite* from Vanartsdalen's quarry.

Finely granular mixture of greenish-black pyroxene with plagioclase and quartz, in smaller quantity, and small grains of titanite and a little pyrrhotite. I analyzed it with the following results:

Loss by ignition,	= 0.30%
Silicic acid,	= 46.38
Titanic acid,	= 2.82
Phosphoric acid,	= 0.47
Alumina,	= 15.63
Ferric oxide,	= 3.03
Ferrous oxide,	= 10.48
Manganous oxide,	= 0.35
Magnesia,	= 8.13

Lime,	= 7.42
Soda,	= 3.68
Potash,	= 0.57
Sulphur,	not determined.
	99.26

No. 4473. Report OO. *Chloritic mineral* from Vanartsdalen's quarry, where it occurs in a band of coarse-grained calcite, between decomposed pyroxene, from which it has been formed. It is mixed with a little graphite. It is soft, impalpable, blackish green, resembling *delessite.* It spec. grav. was found=2.739. The analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 13.49%
Silicic acid,	= 35.23
Alumina,	= 15.45
Ferric oxide,	= 2.64
Ferrous oxide.	= 6.89
Magnesia,	= 24.92
Lime,	= 0.93
	99.55

The lime is probably present as an admixture of carbonate of lime, in which it occurs, and the quantity found would correspond to 1.66 per cent. of the latter.

No. 4504. Report OO. *Graphitic Gneiss* from west side of Neshaminy creek on the property of Phineas Paxon.

Fine-grained mixture of dark-grey quartz, plagioclase, with some brown mica and graphite, and considerable quantity of pyrrhotite.

The analysis made by F. A. Genth, Jr., gave the following results:

Spec. gravity,	= 2.900
Water,	= 1.30%
Graphite,	not determined.
Carbonic acid,	= 0.51
Silicic acid,	=63.93
Titanic acid,	= 1.04
Phosphoric acid,	not determined.
Alumina,	=12.02
Ferric oxide,	= 2.40
Ferrous oxide,	= 2.95
Manganous, niccolous, and cupric oxides,	=traces.
Magnesia,	= 2.44

Lime,	= 4.00
Soda,	= 3.15
Potash,	= 0.84
Pyrrhotite ($Fe_7 S_8$),	= 4.04
	98.62

No. 4532. Report OO. *Chloritic schist*, from half a mile below Willet bridge, on the east side of Neshaminy creek.

Fine, scaly, blackish-green. It has been analyzed by F. A. Genth, Jr., who found:

Spec. gravity,	= 3.054
Loss by ignition,	= 4.01%
Silicic acid,	= 46.35
Titanic acid,	= 0.71
Carbonic acid,	= trace.
Phosphoric acid,	= 0.10
Alumina,	= 15.29
Ferric oxide,	= 1.48
Ferrous oxide,	10.15
Manganous oxide,	0.43
Niccolous oxide,	= trace.
Magnesia,	= 12.06
Lime,	= 8.86
Lithia,	= faintest trace.
Soda,	= 0.33
Potash,	= 0.25
	100.02

No. 4539. Report OO. *Granulite* from S. K. Tomlinson's property W. side of Neshaminy creek, about one mile above the railroad bridge of B. B. R. R., Southampton township, Bucks county.

Consists of a fine granular quartz and feldspar, inclosing grey vitreous quartz in fragments from 5–10^{mm} in length and 1–3^{mm} in thickness, giving the rock somewhat the appearance of pegmatite; there is also a white feldspar present, assuming dimensions of 50^{mm} in length and 10–15^{mm} in width, also a *very minute* quantity of muscovite. An alkali determination of the fine grained portion was made by F. A. Genth, Jr., who obtained:

Soda,	= 5.25%
Potash,	= 0.85

No. 4582. Report OO. *Gneiss* from lands of Frank Praul on east side of Neshaminy creek.

Fine grained mixture of quartz and feldspar with little biotite. It has been examined by F. A. Genth, Jr., who found:

Spec. grav.,	=2.665
Loss by ignition,	= 0.98%
Silicic acid,	= 71.84
Titanic acid,	= 0.31
Phosphoric acid,	= 0.26
Alumina,	= 14.74
Ferric oxide,	= 2.02
Manganous oxide,	= trace.
Magnesia,	= 0.85
Lime,	= 1.74
Lithia,	= faint trace.
Soda,	= 2.98
Potash,	= 4.87
	100.59

No. 4616. Report OO. *Itacolumite*, about 123 paces below Janney's quarry, east side of Neshaminy creek.

Very fine grained quartz, through which are disseminated fine scales of muscovite of a white, a greenish-white and by oxidation of the ferrous oxide, of a reddish color. The mica gives the rock a slaty structure. It also contains small grains of red garnet and hematite. A partial analysis was made by F. A. Genth, Jr., who found:

Loss by ignition,	= 1.66%
Silicic acid,	=84.59
Lithia,	=faint trace.
Soda,	= 0.19
Potash,	= 2.79

No. 4632. Report OO. *Hydromica schist*, from Oakford, west side of Neshaminy creek.

Greyish, fine scaly, micaceous rock, the mica surrounding fine splinters of quartz, also some grains of reddish brown garnet, thus giving the rock a nodular or knotty appearance. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	=7.19%
Lithia,	very strong reaction.
Soda,	=0.76
Potash,	=3.16

No. 4654. Report OO. *Syenitic gneiss* from John P. Townsend's farm on east side of road leading to Hulmeville.

Fine grained stratified rock, composed of feldspar, quartz, greenish-black hornblende and biotite.

The analysis made by F. A. Genth, Jr., gave as follows:

Spec. gravity,	=2.927
Loss by ignition,	= 0.99
Silicic acid,	= 52.36
Titanic acid,	=trace.
Phosphoric acid,	= 0.73
Alumina,	= 16.37
Ferric oxide,	= 0.46
Ferrous oxide,	= 9.05
Manganous oxide,	= 0.33
Magnesia,	= 5.76
Lime,	= 9.49
Lithia,	=trace.
Soda,	= 1.85
Potash,	= 3.20
	100.59

No. 4708. Report OO. *Gneiss*, 1,495 feet from bend of Neshaminy creek, about one and one half miles below where the Delaware River branch of the N. P. R. R. crosses it.

Fine-grained mixture of quartz and feldspar with a small quantity of little scales of muscovite and biotite. It has been examined by F. A. Genth, Jr., who found:

Spec. gravity,	=2.738
Loss by ignition,	= 1.31%
Silicic acid,	= 73.68
Titanic acid,	= 0.81
Phosphoric adid,	= 0.12
Alumina,	= 12.49
Ferric oxide,	= 2.10
Ferrous oxide,	= 2.22
Manganous oxide,	= 0.18
Magnesia,	= 2.04
Lime,	= 0.56
Soda,	= 2.97
Potash,	= 2.91
	101.42

No. 4752. Report OO. *Syenitic gneiss*, 3,118 feet below No. 4708. Banded structure. Granular quartz and feldspar with small grains of garnet and some pyrite, inclosed in large bands of almost pure crystalline greenish-black hornblende. My analysis gave:

Loss by ignition,	= 1.07 %
Silicic acid,	= 48.88
Titanic acid,	= 3.51
Phosphoric acid,	= 0.38
Alumina,	= 12 06
Ferric oxide,	= 7.12
Ferrous oxide,	= 9.54
Manganous oxide,	= 0.55
Magnesia,	= 5.35
Lime,	= 9.50
Soda,	= 1.20
Potash,	= 0.91
Sulphur,	not determined.
	100.07

No. 4771. Report OO. *Gneiss*, 218 feet below No. 4752. Irregular bands of quartz and feldspar, inclosed between scales and sheet-like aggregations of scales of muscovite and biotite. It has been analyzed by F. A. Genth, Jr., who found, as a mean result of two analyses:

Spec. gravity,	= 2.849
Loss by ignition,	= 3.37 %
Silicic acid,	= 56.40
Titanic acid,	= 1.05
Phosphoric acid,	= 0.37
Alumina,	= 19.76
Ferric oxide,	= 4.35
Ferrous oxide,	= 4.40
Manganous oxide,	= trace.
Magnesia,	= 3.11
Lime,	= 0 09
Lithia,	= trace.
Soda,	= 5.82
Potash,	= 1.27
	99.99

No. 4795. Report OO. *Gneiss* from Hulmeville.

Fine-grained mixture of quartz, feldspar and black mica, here and there, with grains of reddish brown garnet and a small quantity of magnetite. Weathered. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 0.58%
Lithia,	exceedingly faint trace.
Soda,	= 2.34
Potash,	= 0.78

No. 4878. Report OO. *Pyroxene-Syenite* from one half mile below Hulmeville in Bensalem twp., on Samuel A. Keen's farm.

Fine-grained mixture of quartz, feldspar, pyroxene and some pyrrhotite. The analysis made by F. A. Genth, Jr., gave:

Spec. gravity,	=2.840
Loss by ignition,	= 2.43%
Silicic acid,	= 62.53
Titanic acid,	= 1.00
Phosphoric acid,	= 0.20
Alumina,	= 12.04
Ferric oxide,	= 1.90
Ferrous oxide,	= 1.41
Pyrrhotite, ($Fe_7 S_8$),	= 2.13
Magnesia,	= 1.80
Lime,	= 11.52
Lithia,	= trace.
Soda,	= 1.25
Potash,	= 2.57
	100.78

No. 4900. Report OO. *Gneiss* from above Newportville dam near the township line. Bristol twp., Bucks co.

Muscovite and biotite, inclosing plagioclase, quartz and a little magnetite; the plagioclase is white with delicate striation and occurs occasionally in larger masses. F. A. Genth, Jr., has analyzed the plagioclase with the following results:

Loss by ignition,	= 0.51%
Silicic acid,	= 62.79
Alumina,	= 23.87
Ferric oxide,	= trace.
Magnesia,	= trace.
Lime,	= 3.26
Soda,	= 8.84
Potash,	= 0.56
	99.83

No. 4949. Report OO. *Enstatite rock* from north side of brook, near roadside below the Flushing Public School House, on Asa Smith's farm.

Enstatite in crystalline masses of a greyish green color, mixed with a dull amorphous mineral of an almost black color, which appears to be serpentine. Between the serpentinic mineral and the enstatite, and intermixed with them, is crystalline calcite or dolomite. I have analyzed both, the total rock and the enstatite which has been picked out as clean as possible.

	Enstatite rock.	*Enstatite.*
Water,	= 6.03%	4.60%
Carbonic acid,	= 4.02	trace.
Silicic acid,	= 45.58	53.29
Alumina,	= 1.40	trace.
Chromic oxide,	= trace.	1.09
Ferric oxide,	= 3.66	3.63
Ferrous oxide,	= 3.36	3.90
Niccolous oxide,	= trace.	0.29
Manganous oxide,	= trace.	trace.
Magnesia,	= 34.23	33.23
Lime,	= 1.78	—
	100.06	100.03

Mesozoic Sandstone.

No. 4975. Report OO. *New red sandstone* from the property of George Justice, west side of Penna. canal, two and one half miles N. of Morrisville, Lower Makefield twp., Bucks co.

Fine-grained conglomerate of greyish white quartz, flesh red feldspar, small scales of mica and some fragments of chlorite. My analysis gave the following results:

Loss by ignition,	= 1.34%
Silicic acid,	= 84.26
Titanic acid,	= 0.96
Phosphoric acid,	= 0.37
Alumina,	= 7.26
Ferric oxide,	= 2.26
Magnesia,	= 0.60
Lime,	= 0.13
Soda,	= 1.43
Potash,	= 1.60
	100.21

Section C.

No. 5247. Report OO. *Chloritic micaceous schist* from the quarry on Jno. & Jas. Anderson's place, on the West branch of Mill creek, three fourths of a mile north of Feasterville.

Greyish-greenish-brown schistose rock, composed of very fine scales of a greenish and brownish color, slightly greasy to the touch. It has been analyzed by F. A. Genth, Jr., who found:

Spec. gravity,	=2.837
Loss by ignition,	= 6.48%
Silicic acid,	= 50.02
Titanic acid,	= 1.32
Phosphoric acid,	= 0.52
Alumina,	= 17.42
Ferric oxide,	= 6.10
Ferrous oxide,	= 5.98
Manganous oxide,	= 0.29
Magnesia,	= 7.24
Lime,	= 1.04
Lithia,	=faint trace.
Soda,	= 0.60
Potash,	= 3.47
	100.48

No. 5268. Report OO. *Mica schist*, from West branch of Mill creek, 270 feet from Anderson's quarry.

Very thin lenticular masses and bands, separated by sheet-like accumulations of very fine scales of mica. I have analyzed it with the following results:

Loss by ignition,	= 1.99%
Silicic acid,	= 76.12
Titanic acid,	= 0 23
Phosphoric acid,	= 0.05
Alumina,	= 13.47
Ferric oxide,	= 1.86
Magnesia,	= 1.22
Lime,	= 0.33
Soda,	= 1.40
Potash,	= 4.08
	100.75

No. 5277. Report OO. *Gneiss* from same locality on W. branch of Mill creek.

Granular quartz with a small quantity of reddish-white feldspar, separated into thin layers by thin sheets of very fine scaly mica. My analysis gave:

Loss by ignition,	= 1.76%
Silicic acid,	= 78.05
Titanic acid,	= 0.78
Phosphoric acid,	= trace.
Alumina,	= 12.35
Ferric oxide,	= 1.57
Magnesia,	= 0.65
Lime,	= 0.38
Soda,	= 1.53
Potash,	= 2.71
	99.78

No. 5278. Report OO. *Chloritic micaceous schist* from same locality on West branch of Mill creek.

Similar in appearance to No. 5247, but more scaly; many of the scales have the appearance of jefferisite. My analysis gave:

Loss by ignition,	= 6.86%
Silicic acid,	= 48.37
Titanic acid,	= 1.21
Phosphoric acid,	= 0.29
Alumina,	= 14.05
Ferric oxide,	= 5.68
Ferrous oxide,	= 6.50
Manganous oxide,	= 0.91
Magnesia,	= 13.57
Lime,	= 1.03
Soda,	= 0.69
Potash,	= 1.44
	100.60

No. 5303. Report OO. *Syenitic gneiss* from bowlders along the valley of the west branch of Mill creek, three fourths of a mile N. of Feasterville.

Fine grained mixture of white feldspar and quartz with a predominating quantity of very fine greenish black hornblende, some titanite, biotite, and pyrite. I have analyzed it (1) and F. A. Genth, Jr., another specimen (2):

	1	2
Loss by ignition,	= 1.40%	1.25%
Silicic acid,	= 50.12	49.80
Titanic acid,	= 2.10	3.94
Phosphoric acid,	= 0.09	trace.
Alumina,	= 15.11	12.55
Ferric oxide,	= 3.39	1.97
Ferrous oxide,	= 8.32	10.23

Pyrite ($Fe S^2$),	= 0.15	0.30
Manganous oxide,	= trace.	0.24
Magnesia,	= 5.44	5.56
Lime,	= 10.35	10.59
Soda,	= 3 01	2.71
Potash,	= 0.65	0.59
	100.13	99.73

No. 5304. Report OO. *Syenitic gneiss* from the same locality.

Greenish-black hornblende in fine particles, inclosing white and greyish-white, granular, dull feldspar, and small grains of pyrite. The analysis, made by F. A. Genth, Jr., gave as follows:

Spec. gravity,	=3.077
Loss by ignition,	= 1.37 %
Silicic acid,	= 49.86
Titanic acid,	= 1.75
Phosphoric acid,	= 0.57
Alumina,	= 17.82
Ferric oxide,	= 3.47
Ferrous oxide,	= 7.60
Pyrite ($Fe S^2$),	= 0.39
Manganous oxide,	=trace.
Magnesia,	= 6.10
Lime,	= 8.62
Soda,	= 2.38
Potash,	= 0.50
	100.43

No. 5306. Report OO. Diorite (?) from bowlders on crest of Buck Ridge, between Feasterville and Vanartsdalen's along the road to Langhorne.

Fine grained, almost black, largely consisting of black hornblende. The other constituents cannot be distinguished by the lens. My analysis gave as follows:

Loss by ignition,	= 1.50 %
Silicic acid,	=47.79
Titanic acid,	= 1.00
Phosphoric acid,	= 0.17
Carbonic acid,	= 0.57
Alumina,	=16.58
Ferric oxide,	= 2.93
Ferrous oxide,	= 9.05
Magnesia,	= 8.17

Lime,	= 9.33
Soda,	= 2.20
Potash,	= 0.40
	99.69

No. 5309. Report OO. *Syenitic gneiss* (?) from the same locality.

Fine grained white feldspar and quartz, with more or less spots and small patches of a greenish-black mineral, which may be hornblende. It has been analyzed by F. A. Genth, Jr., who found :

Spec. gravity,	=2.689
Loss by ignition,	= 1.43%
Silicic acid,	= 73.26
Titanic acid,	= 0.49
Phosphoric acid,	= 0.25
Alumina,	= 12.41
Ferric oxide,	= 1.53
Ferrous oxide,	= 2.31
Manganous oxide,	=trace.
Magnesia,	= 1.05
Lime,	= 1.23
Soda,	= 2.68
Potash,	= 4.51
	101.19

No. 5311. Report OO. *Granite* from the same locality.

Coarse grained, with cleavage masses of white and greyish-white feldspar from 35 to 40^{mm} in diameter, and quartz in smaller grains from 15 to 30^{mm}, and some plates of biotite from 10 to 20^{mm} in size. The feldspar has been analyzed by F. A. Genth, Jr., who found :

Loss by ignition,	= 0.61%
Silicic acid,	= 65.42
Phosphoric acid,	=trace.
Alumina,	= 18.96
Ferric oxide,	= 0.21
Manganous oxide,	=trace.
Magnesia,	= 0.39
Lime,	= 0.45
Soda,	= 2.54
Potash,	= 11.82
	100.40

No. 5321. Report OO. *Graphitic gneiss*, from A. Johnson's Graphite Mine, about one mile east of Feasterville, north of road to Brownsville.

Quartz, with delicately striated feldspar, through which are disseminated small scales and bunches of scales of brown mica with scales of graphite and some pyrite. It has been analyzed by F. A. Genth, Jr., who obtained :

Spec. gravity,	= 2.723
Loss by ignitión,	= 1.47 %
Graphite,	= 1.13
Silicic acid,	= 72.99
Titanic acid,	= 0.84
Phosphoric acid,	= 0.18
Alumina,	= 10.90
Ferric oxide,	= 0.55
Ferrous oxide,	= 2.50
Magnesia,	= 1.07
Lime,	= 1.88
Soda,	= 3.34
Potash,	= 1.20
Pyrite ($Fe S_2$),	= 1.61
	99.66

No. 5348. Report OO *Itacolumite* from quarry on S. Road's place, near Somerton.

Sheet-like accumulations of fine scaly white and greenish-white mica, interstratified with fine-grained quartz.

I have analyzed the scaly portion, which, however, contained much free quartz ;

Loss by ignition,	= 3.73 %
Silicic acid,	= 58.97
Titanic acid,	= 1.11
Phosphoric acid,	= 0.07
Alumina,	= 22.61
Ferric oxide,	= 5.67
Magnesia,	= 0.25
Lime,	= 0.08
Soda,	= 0.32
Potash,	= 7.34
	100.15

Itacolumite from one and one half miles south east of Vanartsdalen's. Received from Mr. Theodore D. Rand.

Greenish-yellowish and greyish-white micaceous schist, containing fine-grained quartz.

The analysis made by F. A. Genth, Jr., gave as follows :

Spec. gravity,	= 2.741
Loss by ignition,	= 1.20%
Silicic acid,	= 87.87
Titanic acid,	= 0.38
Phosphoric acid,	= 0.06
Alumina,	= 6.61
Ferric oxide,	= 2.39
Manganous oxide,	= 0.13
Magnesia,	= trace.
Lime,	= 0.24
Soda,	= 0.19
Potash,	= 1.73
	100.80

Section D.

No. 5469. Report OO. *Gneiss* from Pennypack creek about 689 yards below Woodside station on the east side of the railroad on C. Yerkes' property.

Fine grained, principally composed of white feldspar with grains of grey quartz and scales of black biotite, very little magnetite, some pyrite and a few grains of reddish-brown garnet. It has been analyzed by F. A. Genth, Jr., who found :

Spec. grav.,	= 3.152
Loss by ignition,	not detd.
Silicic acid,	= 49.90
Titanic acid,	= 1 89
Phosphoric acid,	= 0.32
Alumina,	= 13.51
Ferric oxide,	= 5.38
Ferrous oxide,	= 10.76
Pyrite, ($Fe S_2$),	= 3.47
Magnesia,	= 3.59
Lime,	= 8.77
Soda,	= 1.96
Potash,	= 0.56
	100.11

No. 5495. Report OO. *Gneiss* (?) 358 feet below Paper-mill station on the Philadelphia and Newtown Railroad, Moreland Twp., Montgomery co.

It is composed of brownish and greyish-white quartz and white and greenish feldspar. Disseminated through this granular mixture are spots and patches of fine scaly biotite. Where the rock is coarser, the individual constituents averaging from 2 to 4^{mm} in diameter, it is almost free from biotite, elsewhere the latter is disseminated through the fine grained mass in spots from 1 to 3^{mm}, rarely larger, giving the rock a leopard like appearance. It has been analyzed by F. A. Genth, Jr., with the following results:

Spec. gravity,	=2.765
Loss by ignition,	= 0.80%
Silicic acid,	=64.34
Titanic acid,	= 1.20
Phosphoric acid,	= 0.19
Alumina,	=16.61
Ferric oxide,	= 2.00
Ferrous oxide,	= 3.96
Manganous oxide,	= 0.33
Magnesia,	= 0.38
Lime,	= 3.32
Lithia,	=faint trace.
Soda,	= 2.84
Potash,	= 3.61
	99.58

No. 5514. Report OO. *Granulite* from railroad cut, 605 feet south of Howe's truss bridge, Moreland twp., Montgomery county.

Fine-grained quartz or mixture of very fine feldspar, with quartz disseminated through it. A partial analysis has been made by F. A. Genth, Jr., who found:

Loss by ignition,	= 0.75%
Soda,	= 4.06
Potash,	= 3.50

No. 5526. Report OO. *Micaceous schist* from 145 paces above South end of the second Howe's truss bridge below Byberry road.

Schistose and somewhat shaly; composed largely of, partly altered, biotite and green fibrous actinolite. My analysis gave:

Loss by ignition,	= 1.16%
Silicic acid,	= 46.82
Titanic acid,	=trace.
Phosphoric acid,	= 0.46
Alumina,	= 9.43
Ferric oxide,	= 2.98
Ferrous oxide,	= 7.68

Manganous oxide,	= 0.14
Niccolous oxide,	= 0.24
Cobaltous oxide,	= trace.
Chromic oxide,	= 0.28
Magnesia,	= 17.88
Lime,	= 6.19
Lithia,	strong reaction.
Soda,	= 0.44
Potash,	= 4.49
	98.19

No. 5530. Report OO. *Gneiss* from 120 paces South of second bridge below Byberry road, West side of Pennypack creek.

A peculiar rock, largely composed of white dull feldspar, with indistinct cleavage. The interstices between the granular feldspar particles, which are 1 to 2mm. in diameter, are surrounded by fine scaly brown mica. There appears to be only a small quantity of quartz in the rock composition, but veins and patches of bluish-white quartz are disseminated through it; also, in small quantity grains of reddish-brown garnet. F. A. Genth, Jr., made an analysis of the rock and found:

Spec. gravity,	=2.626
Loss by ignition,	= 0.99%
Silicic acid,	= 61.83
Titanic acid,	= 2.41
Phosphoric acid,	= 0 32
Alumina,	= 17.32
Ferric oxide,	= 1.31
Ferrous oxide,	= 5.53
Magnesia,	= 1.41
Lime,	= 3.33
Soda,	= 3.10
Potash,	= 2.00
	99.55

No. 5540. Report OO. *Gneiss*, 511 feet below No. 5530.

Slaty, brown biotite, inclosing grains and very thin particles of quartz and feldspar. It has been analyzed by F. A. Genth, Jr.

Spec. gravity,	=2.899
Loss by ignition,	= 1.56%
Silicic acid,	= 56.37
Titanic acid,	= 1.09

Phosphoric acid,	= 0.30
Alumina,	= 15.31
Ferric oxide,	= 3.49
Ferrous oxide,	= 6.24
Manganous oxide,	= 0.59
Magnesia,	= 4.34
Lime,	= 5.36
Lithia,	= trace.
Soda,	= 1.85
Potash,	= 3.73
	100.23

No. 5555. Report OO. *Syenitic Gneiss*, from a place 607 paces below center of road at C. Fetter's mill.

Greenish-black crystalline hornblende from 1 to $6^{mm.}$ in size, with a considerable quantity of white feldspar. (Quartz could not be distinguished by the lens.) My analysis gave:

Loss by ignition,	= 0.96%
Silicic acid,	= 47.43
Titanic acid,	= 2.00
Phosphoric acid,	= 0.12
Alumina,	= 17.69
Ferric oxide,	= 2.49
Ferrous oxide,	= 10.94
Manganous oxide,	= 0.19
Magnesia,	= 5.32
Lime,	= 9.11
Lithia,	= trace.
Soda,	= 2.48
Potash,	= 0.72
	99.45

No. 5572. Report OO. *Gneiss*, from a place 2135 feet below No. 5555.

Largely consisting of plagioclase in distinctly cleavable particles from 1 to $3^{mm.}$ in diameter; inclosed in it are grains of a blueish and greyish-white quartz, and disseminated through the whole mass, sometimes in patches, fine scaly brown and dark greenish mica, probably with a little hornblende and magnetite. It has been analyzed by F. A. Genth, Jr., who found:

Spec. gravity,	=2.769
Loss by ignition,	= 0.89%
Silicic acid,	= 65.79
Titanic acid,	= 0.90
Phosphoric acid,	= 0.08

Alumina,	= 16.63
Ferric oxide,	= 1.92
Ferrous oxide,	= 3.72
Manganous oxide,	= trace.
Magnesia,	= 1.55
Lime,	= 4.07
Soda,	= 4.71
Potash,	= 0.68
	100.94

No. 5772. Report OO. *Gneiss* from the upper side of bridge, crossing Pennypack creek at Verree's mills.

White feldspar, quartz and biotite, the latter in brown and brownish-black scales in great quantity, also small quantities of pyrrhotite and magnetite. The analysis made by F. A. Genth, Jr., gave:

Spec. gravity,	= 2.799
Loss by ignition,	= 1.92%
Silicic acid,	= 59.39
Titanic acid,	= 1.24
Phosphoric acid,	= 0.13
Alumina,	= 16.38
Ferric oxide,	= 4.82
Ferrous oxide,	= 1.96
Pyrrhotite, (Fe_7 S_8)	= 3.06
Magnesia,	= 2.11
Lime,	= 7.33
Lithia,	= trace.
Soda,	= 0.53
Potash,	= 1.64
	100.51

Section E.

No. 5892. Report OO. (Potsdam) *Hydromica shale*, from 370 paces S. W. from switch, connecting the siding of Shaw & Newport's bone factory, one half mile S. W. from Willow Grove station, Abington twp., Montgomery co.

Almost crypto-crystalline, very fine scaly, somewhat ferruginous, greyish-brownish-white; slight pearly luster. The analysis was made by F. A. Genth, Jr., who found:

Loss by ignition,	= 2.89%
Silicic acid,	= 56.35
Titanic acid,	= 0.82
Phosphoric acid,	= 0.16
Alumina,	= 22.28
Ferric oxide,	= 3.21

Magnesia,	= 1.40
Lime,	= 0.19
Lithia,	strong reaction.
Soda,	= 0.38
Potash,	= 12.63
	100 31

No. 5894. Report OO. (Potsdam) *Hydromica shale*, 33 feet below No. 5892.

Similar, but more quartoze, and feeling rough to the touch. Color paler brownish-white. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 1.32%
Silicic acid,	=78.12
Soda,	= 0.20
Potash,	= 7.83

No. 5929. Report OO. *Hydromica schist* (?) from north of Jenkintown Junction on the west side of Tacony creek.

A grey micaceous rock. The particles are intimately interwoven and contain grains of garnet, white feldspar and very litte magnetite. The analysis made by F. A. Genth, Jr., gave as follows:

Spec. gravity,	= 2.922
Loss by ignition,	= 2.78%
Silicic acid,	= 60 33
Titanic acid,	= 1.41
Phosphoric acid,	= 0.28
Alumina,	= 20.85
Ferric oxide,	= 3.59
Ferrous oxide,	= 4.47
Magnesia,	= 2.07
Lime,	= 1.82
Soda,	= 1.38
Potash,	= 2.84
	101.82

No. 6101. Report OO. *Gneiss* from the east side of the creek in the upper part of Frankford.

Finely granular greyish-white rock, made up of feldspar and quartz, small scales of biotite and a little magnetite.

The analysis made by F. A. Genth, Jr., gave the following results:

Spec. gravity,	= 2.658
Loss by ignition,	= 0.48%
Silicic acid,	=74.24

Titanic acid,	= 0.36
Phosphoric acid,	= 0.26
Alumina,	=13.71
Ferric oxide,	= 2 01
Magnesia,	= 1.09
Lime,	= 1.68
Lithia,	=trace.
Soda,	= 0.60
Potash,	= 4.84
	99.27

Gneiss from Frankford. The specimen was presented to me by Mr. Theodore D. Rand.

It is of fine granular texture, composed of greyish-white quartz, and white feldspar; disseminated through the mass are spots of fine scaly biotite, frequently inclosing particles of red garnet.

The analysis made by F. A. Genth, Jr., gave as follows:

Spec gravity,	= 2.657
Loss by ignition,	= 0.50%
Silicic acid,	=75 04
Titanic acid,	= 0.50
Phosphoric acid,	= 0.31
Alumina,	=12.59
Ferric oxide,	= 2.45
Magnesia,	= 0 38
Lime,	= 1.44
Soda,	= 1.62
Potash,	= 3.98
	98.81

Gneiss from Frankford. This and the following were also presented to me by Mr. Theo. D. Rand.

It is of fine-grained texture and a mixture of feldspar and quartz of a yellowish-greyish-white color, and disseminated through it are dark stripes, produced by fine scales of biotite.

The analysis was made by F. A. Genth, Jr., who found:

Spec. gravity,	= 2.667
Loss by ignition,	= 0.38%
Silicic acid,	= 75.15
Titanic acid,	= 0.28
Phosphoric acid,	= 0.22
Alumina,	= 13.15
Ferric oxide,	= 2.70
Magnesia,	= 0.68

Lime,	= 1.31
Lithia,	=trace.
Soda,	= 1.95
Potash,	= 5.21
	101.03

Granite from Frankford.

Fine-grained, almost wholly composed of quartz and feldspar with little mica. It has been analyzed by F. A. Genth, Jr., who found:

Spec. gravity,	=2.754
Loss by ignition,	= 0.74%
Silicic acid,	= 73.59
Titanic acid,	= 1.80
Phosphoric acid,	= 0.07
Alumina,	= 11.37
Ferric oxide,	= 2.82
Manganous oxide,	= trace.
Magnesia,	= 0.77
Lime,	= 1.62
Lithia,	= trace.
Soda,	= 2.07
Potash,	= 4.65
	99.50

Section F.

(Potsdam.) *Hydromica slate* from the railroad cut, one fourth of a mile below Fort Washington Station, N. Pa. R. R.

Greyish-green and reddish slate, slightly greasy to the touch. It has been analyzed by F. A. Genth, Jr., who found as follows:

Spec. gravity,	=3.120
Loss by ignition,	= 3.32%
Silicic acid,	= 56.28
Titanic acid,	= 2.79
Phosphoric acid,	= 0.19
Alumina,	= 20.88
Ferric oxide,	= 3.56
Manganous oxide,	= trace.
Magnesia,	= 1.71
Lime,	= 1.12
Soda,	= 1.00
Potash,	= 10.24
	101.09

No. 6121. Report OO. (Potsdam.) *Hydromica schist* from railroad cut on N. P. R. R., one half mile S. E. from Fort Washington.

A dark grey, siliceous, slaty rock, composed, apparently, mostly of fine grained quartz, and, disseminated through it, very fine micaceous scales, which give it a slaty structure. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 1.78%
Silicic acid,	= 64.74
Lithia,	=faint trace.
Soda,	= 0.22
Potash,	= 8.39

No. 6132. Report OO. *Limestone* from the East side of the Wissahickon creek, one mile South of Fort Washington.

Very fine-grained and of a yellowish-white color. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition=carbonic acid and water,	=46.86%
Residue, insoluble in ammonium chloride,	= 1.70

No. 6133. Report OO. *Limestone.*

Compact, very fine-grained and of greyish-white color. A partial analysis like the last has been made by F. A. Genth, Jr., who has also made all the following partial limestone analyses:

Loss by ignition=carbonic acid and water,	=46.43%
Residue, insoluble in ammonium chloride,	= 2.73

No. 6143. Report OO. *Limestone* from West side of Wissahickon creek, about one fourth mile below where the Plymouth Railroad crosses the creek, near the Bethlehem pike. Of somewhat coarser grain. It gave:

Loss by ignition=carbonic acid and water,	=47.22%

No. 6145. Report OO. *Limestone*, 133 paces below No. 6143.

Very fine-grained, yellowish-white. It is lined on one side by quartz and hydromica slate. It gave:

Loss by ignition=carbonic acid and water,	=46.68%
Residue, insoluble in ammonium chloride,	= 2.09

No. 6147. Report OO. *Limestone*, from 300 feet from dyke, where the Lancasterville road crosses the creek, on its west side, north from house of Mr. Lukens.

Granular white limestone, including small scales of yellowish-white and white mica. The partial analysis gave:

Loss by ignition=carbonic acid and water,	=42.55%
Soda,	= 0.06
Potash,	= 0.35

No. 6149. Report OO. *Limestone* from a locality 210 paces below No. 6147.

Slaty greyish-white fine granular, with fine scales of mica, disseminated through it, one side being lined with larger scales. The partial analysis gave:

Loss by ignition=carbonic acid and water,	=39.07%
Residue, insoluble in ammonium chloride,	=21.91
Soda,	= 1.15
Potash,	= 1.39

No. 6159. Report OO. (Potsdam) *Hydromica schist* from the quarry on the north side of Wissahickon pike, 150 yards west from the bridge, crossing the creek. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 1.05%
Silicic acid,	=90.01
Soda,	= 0.19
Potash,	= 1.90

Section G.

Limestones from Mogeetown to Potts' Landing Station of P. and R. R.R., Plymouth twp., Montgomery co.

Partial analyses gave as follows:

	Nos. 7106.	7109.	7124.	7143.	7159.	7169.
Insoluble residue in hydrochloric acid,	=not detd.	2.59%	26.48%	46.10%	37.60	2.65%
Carbonate of lime,	=60.18%	55.09	41.59	39.95	48 04	63.36
Carbonate of iron,	=not detd.	not detd.	not detd.	2.55	not detd.	not detd.

I have made a more complete analysis of No. 7159, and of the residue which is left of the ignited limestone by treatment with ammonium chloride. The following are the results:

Carbonate of lime,	= 40.27%
Carbonate of magnesia,	= 31.24
Residue, insoluble in ammonium chloride,	= 28.49
	100.00

The residue contained:

Silicic acid,	=24.23%
Alumina,	= 1.12
Ferric oxide,	= 1.06
Magnesia,	= 0.11
Lime,	= 0.55
Alkalies, &c., &c.,	= 1.42
	28.49

Limestones from Potts' Landing station to Conshohocken, on the east side of the Schuylkill river. The following partial analyses gave:

	No. 7170.	7171.	7174.	7181.	7187.	7206.
Insoluble in hydrochloric acid,	= 7.85%	9.83%	5.89%	6.60%	5.63	4.79%
Carbonate of lime,	=91.62	53.27	58.02	61.43	93.32	85.00

No. 7214. Report OO. *Hydromica schist;* exposure at water's edge on W. side of Schuylkill river, W. Conshohocken.

Grains or sheets, or patches of fine grained quartz, interlaminated with greyish and greenish-white mica, turning brownish on weathering.

On ignitiun it gives a loss of, ... 4.41%

No. 7220. Report OO. *Mica schist* from Front street, W. Conshohocken.

Very thin sheets of fine grained quartz, intimately intercalated or interwoven with brownish-grey mica, which

On ignition gives a loss of, ... =4.90%

No. 7222. Report OO. *Blue limestone* from Mr. Davis' property, 150 yards S. W. from Front street, W. Conshohocken. A partial analysis gave:

Insoluble in hydrochloric acid,	= 3.15%
Carbonate of lime,	=54.11

No. 7225. Report OO. *White marble* of fine grain, from Mr. Davis' quarry, 582 feet below No. 7222. The partial analysis gave:

Insoluble in hydrochloric acid,	= 1.78%
Carbonate of lime,	=97.86

No. 7234. Report OO. *Mica schist* or *Gneiss?* from the south side of Schuylkill river, east from W. Conshohocken.

Almost the whole rock appears to be a fine grained quartz, with only a few scales of muscovite disseminated. A partial analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 0.22%
Soda,	= 0.27
Potash,	= 2.95

No. 7288. Report OO. *Talcose chlorite slate* from Prince's Soapstone Quarry, below Lafayette station.

Greyish-green slaty, with a few scales of talc and a little magnetite disseminated through it. The analysis made by F. A. Genth, Jr., gave the following composition:

Loss by ignition,	= 9.07%
Silicic acid,	= 41.80
Titanic acid,	= 0.52
Phosphoric acid,	=trace.
Alumina,	= 10.39
Ferrous oxide,	= 7.29
Magnesia, (by difference,)	= 26.71
Lime,	= 3.89
Soda,	= 0.27
Potash,	= 0.06
	100.00

Chlorite slate from Prince's quarry near Lafayette, collected with the other samples from the same locality, and the specimens from Rose's quarry on the west side of the Schuylkill, opposite Lafayette, by F. A. Genth, Jr.

Greenish, fine scaly. It has been analyzed by F. A. Genth, Jr., (I) and Frank Julian (II), who found:

	I.	II.
Loss by ignition,	=12.60%	12.56%
Silicic acid,	=32.78	32.80
Alumina,	=17.53	17.70
Ferric oxide,	= 1.31	1.60
Ferrous oxide,	= 3.90	3.85
Magnesia,	=31.56	31.95
	99.68	100.46

Talc from Prince's Soapstone Quarry.

Very fine scaly, silvery white, inclosed in crystalline masses of dolomite, and remaining, on dissolving the latter in hydrochloric acid. Largely exfoliating on ignition, like pyrophyllite. I have analyzed it and found:

Loss by ignition,	= 5.96%
Silicic acid,	= 65.16
Alumina,	= 0.25
Ferrous oxide,	= 1.39
Magnesia,	= 27.40
	100.16

Dolomite from Prince's Soapstone Quarry.

Large cleavage masses of greyish-white color. It has been analyzed by F. A. Genth, Jr., who found :

Spec. gravity,	= 2.898
Carbonic acid,	= 47.08%
Ferrous oxide,	= 1.89
Manganous oxide,	= 0.14
Magnesia,	= 20.74
Lime,	= 30.10
	99.95

Calculating the bases as carbonates, we get :

Ferrous carbonate,	= 3.05%
Manganous carbonate,	= 0.23
Magnesium carbonate,	= 43.55
Calcium carbonate,	= 53.75
	100.58

Enstatite from Rose's quarry, opposite and above Lafayette.

Dark brownish-grey, crystalline, the cleavage particles from 5 to 10^{mm} in diameter. The purest, apparently unaltered mineral was analyzed in the Laboratory of the University of Pennsylvania by Henry Trimble, who found :

	I.	II.
Silicic acid,	= 53.41%	53.32%
Alumina,	= 2.12	2.13
Ferric oxide,	= 4.66	4.72
Ferrous oxide,	= 5.71	5.71
Manganous oxide,	= 0.87	0.38
Magnesia,	= 32.47	33.72
	99.24	99.98

This enstatite is generally more or less altered, forming serpentine and similar minerals and intermediate mixtures. The slaty (I) which gradually becomes serpentine, and the yellowish and greyish-white, waxy mineral (II a. b. &c.,)

(see Report B, 105,) have been analyzed by F. A. Genth, Jr., who found :

	I.	IIa.	b.	c.
Loss by ignition, . . =	5.96%	4.88%	4.96%	5.03%
Silicic acid, ... =	50.84	62.24	62.00	61.34
Chromic oxide, . . . =	2.33	—	—	—
Alumina, ... =	4.33 }	4.00	3.66	4.13
Ferric oxide, ... =	1.31 }			
Ferrous oxide, ... =	6.81	—	—	—
Niccolous oxide, . . =	0.05	—	—	—
Manganous oxide, . . =	0.18	0.37	0.34	not detd.
Magnesia, ... =	28.75	29.59	29.89	29.70
Lime, ... =	trace.	—	—	—
	100.56	101.08	100.85	100.20

Chloritic mineral from Rose's quarry, (see Report B, 134.)

Scaly granular, and of a dark green color; resulting from the alteration of enstatite.

It has been analyzed by F. A. Genth, Jr., who found :

Spec. gravity, ...	=2.620
Loss by ignition, ... =	12.88%
Silicic acid, ... =	39.39
Alumina, ... =	5.07
Ferric oxide, ... =	4.69
Ferrous oxide, ... =	3.25
Magnesia, ... =	34.34
Lime, ... =	trace.
	99.62

Titanite from Hornblende rock at Tioga Station on the Philadelphia and Germantown Railroad.

The rock consists of coarse-grained greenish-black hornblende and white plagioclase, graduating into a fine-grained rock. In the coarse portion are crystals and crystalline masses, sometimes one inch in diameter of liver-brown *titanite.* I have analyzed it and found as follows :

	By sodium carbonate.	*By hydrofluoric acid.*
Spec. gravity, ...	=3.596	
Loss by ignition, ... =	0.99%	0.87%
Silicic acid, ... =	30.60	—
Titanic acid, ... =	37.23	37.02
Alumina, ... =	0.67	0.47
Ferrous oxide, ... =	0.90	0.90
Manganous oxide, ... =	trace.	trace.

Magnesia, ... =	0.24	trace.
Lime, ... =	29.50	29.38
	100.13	

Coarse-grained *granite* from Schuylkill, opposite Fairmount Water Works, consisting of granular grey quartz with large crystals of orthoclase of a flesh-red color and crystals of white oligoclase, and traces only of muscovite.

I have analyzed the orthoclase (I) and oligoclase (II) crystals from this granite, also a white oligoclase (III) from Forty-fourth Street and Baltimore Ave., W. Philadelphia.

	I.	II.	III.
Loss by ignition, ... =	0.23%	0.13%	0.39%
Silicic acid, ... =	66.04	65.95	64.54
Alumina, ... =	19.02	22.40	22.90
Ferric oxide, ... =	0.21	trace.	0.15
Manganous oxide, ... =	—	—	trace.
Magnesia, ... =	0.09	trace.	0.02
Lime, ... =	0.18	2.46	3.61
Soda, ... =	2.13	8.15	8.05
Potash, ... =	11.68	0.78	0.54
	99.58	99.87	100.20

Biotite.—Two varieties have been analyzed ; one which is frequently interfoliated with muscovite from the neighborhood of Forty-fourth Str. and Baltimore Ave. and which has a brownish-black color has been analyzed by me (I) ; the other from the same locality, occurring in imperfect crystals of about one to two inches in diameter and about one eighth of an inch in thickness, which has also a brownish-black color, by F. A. Genth, Jr.(II.)

	I.	II.
Loss by ignition, ... =	2.97%	2.07%
Fluorine, ...	not determined.	not determined.
Silicic acid, ... =	36.02	36.19
Titanic acid, ... =	2.20	1.68
Alumina, ... =	18.95	21.66
Ferric oxide, ... =	3.17	2.64
Ferrous oxide, ... =	16.44	16.96
Cupric oxide, ... =	0.10	trace.
Manganous oxide, ... =	0.67	0.52
Magnesia, ... =	9.39	9.36
Lithia, ... =	trace.	trace.
Soda, ... =	0.29	0.45
Potash, ... =	9.25	8.51
	99.45	100.04

Hornblende slate from West Philadelphia.

Finely granular, dark green hornblende with slaty structure. I have analyzed the greenish-black hornblende, which has been picked out with great care, but which notwithstanding contained a considerable admixture of titanite and feldspar. I found:

Loss by ignition,	= 1.13%
Silicic acid,	= 40 50
Titanic acid,	= 5.60
Alumina,	= 12.47
Ferric oxide,	= 9.15
Ferrous oxide,	= 12.63
Manganous oxide,	= 0 13
Magnesia,	= 7.79
Lime,	= 9.50
Soda,	= 1 01
Potash,	= 0.53
	100.44

Section H.

No. 7701. Report OO. *Granular calcite* from the North end of Hitner's marble quarry, one mile North of Gulf Mills.

Fine grained greyish-white. The analysis made by F. A. Genth, Jr., gave:

Loss by ignition=carbonic acid and water,	= 42.46%
Silicic acid,	= 1.18
Alumina, Ferric oxide,	= 2.01
Lime,	= 53 48
Magnesia, (by difference,)	= 0.87
	100.00

No. 7704. Report OO. *Hydromica schist* from road between Gulf Mills and Hitner's marble quarry.

Brownish-grey, of somewhat silky luster; breaks into very thin laminæ. The analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 7.52%
Silicic acid,	= 43.81
Titanic acid,	= 3.78
Phosphoric acid,	= 0.13
Alumina,	= 27.52
Ferric oxide,	= 7.30

Ferrous oxide,	=trace.
Magnesia,	= 1.77
Lime,	= 0.19
Lithia,	=trace.
Soda,	= 0.56
Potash,	= 8.81
	101.39

No. 7733. Report OO. *Ferruginous Hydromica schist* from 355 paces below Mr. Hughes' residence, between Gulf Mills and King of Prussia.

Slates, breaking into very fine layers, consisting of fine scales of micaceous mineral, colored reddish by ferric oxide. The analysis made by F. A. Genth, Jr., gave:

Loss by ignition,	= 5.91%
Silicic acid,	= 43.10
Titanic acid,	= 3.28
Phosphoric acid,	=trace.
Alumina,	= 30.86
Ferric oxide,	= 7.28
Magnesia,	= 1.80
Soda,	= 0.66
Potash,	= 6.87
	99.76

No. 7773. Report OO. *Hydromica slate* 1222 feet from "Bird-in-Hand" tavern on the road from Gulf Mills to Bryn Mawr.

Very fine scaly, greenish-grey. I have analyzed it with the following results:

Loss by ignition,	= 6.05%
Silicic acid,	= 39.35
Titanic acid,	= 1.20
Phosphoric acid,	= 0.49
Alumina,	= 31.92
Ferric oxide,	= 2.19
Ferrous oxide,	= 9 00
Niccolous (with trace of cobaltous) oxide,	= 0.06
Magnesia,	= 3.08
Soda,	= 1.98
Potash,	= 5.26
	100.58

No. 7789. Report OO. *Dolerite*, 2336 feet from "Bird-in-Hand" tavern on the road from Gulf Mills to Bryn Mawr.

Compact, greenish-grey crypto-crystalline rock. It was analyzed by F. A. Genth, Jr., who found:

Loss by ignition,	= 2.15%
Silicic acid,	= 51.56
Titanic acid,	= 1.63
Phosphoric acid,	= 0.13
Alumina,	= 17.38
Ferric oxide,	= 6.57
Ferrous oxide,	= 3.85
Magnesia,	= 3.42
Lime,	= 10.19
Lithia,	=trace.
Soda,	= 2.19
Potash,	= 1.46
	100.53

No. 7865. Report OO. On road leading from Bryn Mawr to Merion Square; from north end of exposure.

A greyish and greenish-white rock, apparently a mixture of talc with magnesite and dolomite. I have made a partial analysis, which gave:

Water,	= 10.73%
Magnesium carbonate,	= 10.57
Calcium carbonate,	= 5 03
Magnesia, (as silicate,)	= 3.29

Syenitic porphyritic gneiss (?), presented to me by Mr. Theodore D. Rand, who collected it at a locality one eighth of a mile N. E. of Villa Nova station, Pa. R.R., Montgomery co.

It has a brownish color, produced by innumerable minute scales of biotite; there is also a small admixture of greenish-black hornblende, and disseminated through the whole mass are rounded patches of plagioclase from 2 to 15^{mm} in diameter. It has been analyzed by F. A. Genth, Jr., who found:

Loss by ignition,	= 0.77%
Silicic acid,	=59 31
Titanic acid,	= 0.90
Phosphoric acid,	= 0.28
Alumina,	=16.85
Ferric oxide,	= 2.43
Ferrous oxide,	= 6.37
Magnesia,	= 2.68
Lime,	= 5.51

Soda,	= 2.57
Potash,	= 1.89
	99.56

Gneiss, from Elm station, Pa. R.R., Montgomery co. Collected and presented to me by Mr. Theodore D. Rand.

A very fine-grained mixture of quartz and feldspar with little fine scaly mica; easily breaking into flat angular pieces. It has been analyzed by F. A. Genth, Jr., with the following results:

Spec. gravity,	=2.726
Loss by ignition,	= 1.66%
Silicic acid,	= 79.60
Titanic acid,	= 0.71
Phosphoric acid,	= 0.19
Alumina,	= 9.48
Ferric oxide,	= 1.77
Ferrous oxide,	= 1.49
Manganous oxide,	= 0.67
Magnesia,	= 0.76
Lime,	= 0.72
Lithia,	very faint trace.
Soda,	= 1.83
Potash,	= 1.54
	100.42

No. 8239. Report OO. *Dolomite* from limestone quarry near ticket office at Downingtown station, Pa. R.R.

Finely granular bluish-grey, with small veins of white, a very little pyrite and some hydromica slate. Analyzed by F. A. Genth, Jr., who found:

Loss by ignition=carbonic acid and water,	=38.52%
Silicic acid and insoluble silicates,	=15.67
Alumina and ferric oxide,	= 2.30
Magnesia,	=14.74
Lime,	=28.36
	99.59

No. 8247. Report OO. *Limestone* from the quarry of Edge T. Cope, Copeville, W. Bradford twp., Chester co.

Granular calcite, with small scales of phlogopite and some grains of pyrrhotite. It was analyzed by F. A. Genth, Jr.:

Loss by ignition=carbonic acid and water,	=32.00%
Silicic acid,	=21.53
Alumina and ferric oxide,	= 3.60
Pyrrhotite, (Fe_7 S_8),	= 1.06
Magnesia,	= 1.46
Lime,	=38.38
Soda,	= 0.33
Potash,	= 1.18
	99.54

No. 8275. Report OO. *Coarse gneiss*, extending from railroad cut, ¼ mile above Chadd's Ford to where the Phila. & Balto. Central R.R. crosses the Wilmington & Northern R.R.; 50 below north end of R.R. cut, in Pennsbury twp.

This gneiss contains masses of a greyish-white cleavable feldspar without striation, which was found, by my analysis, to be *orthoclase*. It contains:

Loss by ignition,	= 0.38%
Silicia acid,	= 65.21
Alumina,	= 18.51
Ferric oxide,	=trace.
Magnesia,	= 0.04
Lime,	= 0.14
Soda,	= 1.77
Potash,	= 14.02
	100.07

F. A. GENTH.

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A. Index of Names.

B. Index of Minerals.

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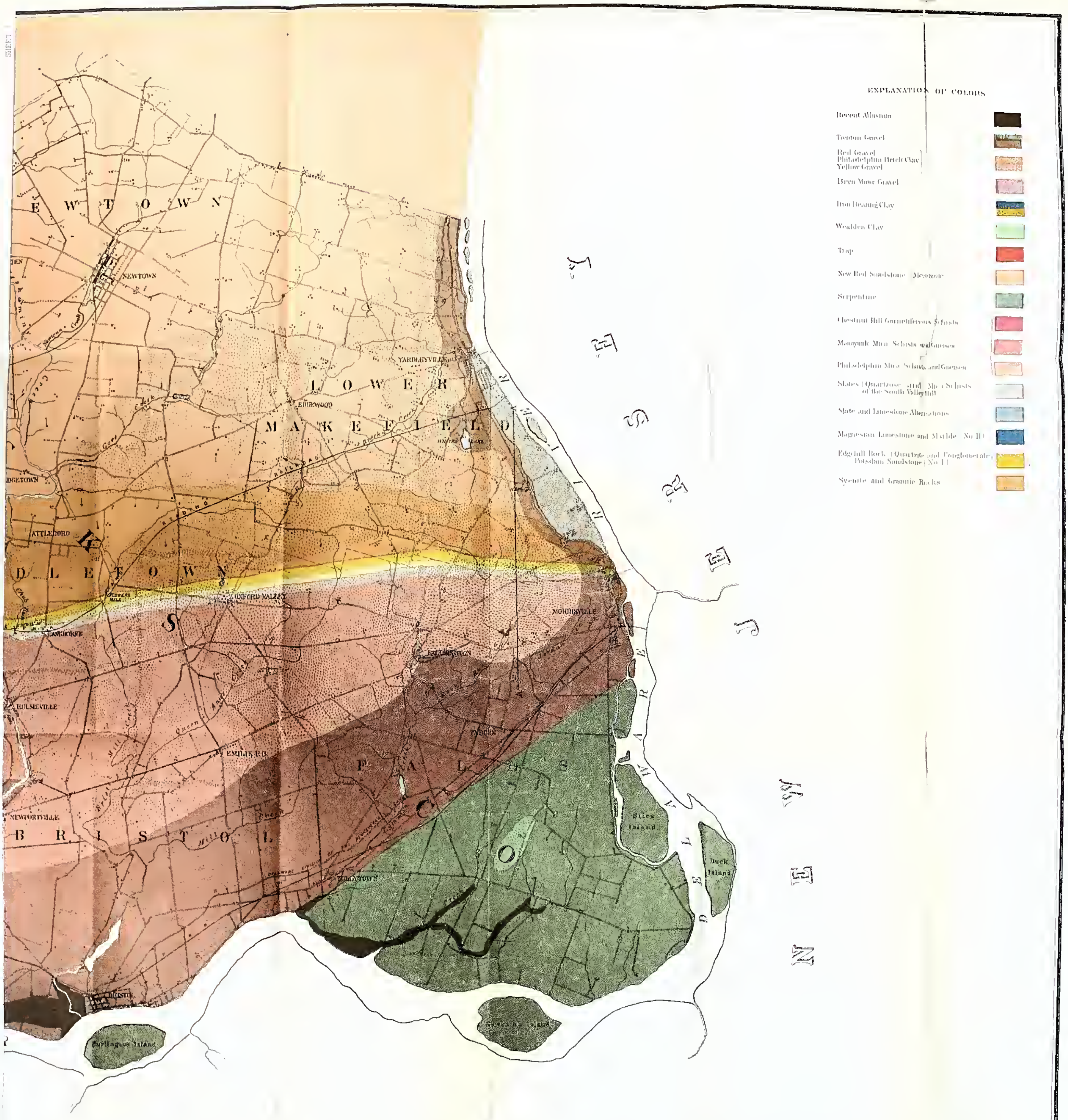

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J. P. LESLEY, State Geologist

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THE EASTERN END OF THE
LIMESTONE VALLEY OF CHESTER COUNTY,
THE SOUTHERN EDGE OF THE
NEW RED SANDSTONE OF BUCKS AND MONTGOMERY,
AND THE
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